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Templeton, Jr. et al.

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[54] **ELECTRICAL INTERCONNECTION FOR STRUCTURE INCLUDING ELECTRONIC AND/OR ELECTROMAGNETIC DEVICES**

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[21] Appl. No.: **235,820**

[22] Filed: **Apr. 29, 1994**

[51] **Int. Cl.**[6] ..... **H05K 7/10**

[52] **U.S. Cl.** ..... **235/492**; 29/832; 361/737; 439/66

[58] **Field of Search** ..... 439/66, 68, 74, 439/91, 76; 361/737, 760, 761, 763, 764; 235/488, 492; 29/830, 832, 842

[56] **References Cited**

U.S. PATENT DOCUMENTS

| | | | |
|---|---|---|---|
| 3,680,037 | 7/1972 | Nellis et al. | 439/66 |
| 3,702,464 | 11/1972 | Castrucci | 340/173 SP |
| 3,971,916 | 7/1976 | Moreno | 235/61.7 B |
| 4,338,621 | 7/1982 | Braun | 257/697 |
| 4,420,767 | 12/1983 | Hodge et al. | 439/71 |
| 4,539,622 | 9/1985 | Akasaki | 361/764 |
| 4,742,385 | 5/1988 | Kohmoto | 439/68 |
| 4,954,308 | 9/1990 | Yabe et al. | 264/272.17 |
| 4,960,983 | 10/1990 | Inoue | 235/488 |
| 5,018,051 | 5/1991 | Yamada et al. | 235/492 |
| 5,109,320 | 4/1992 | Bourdelaise et al. | 36/764 |

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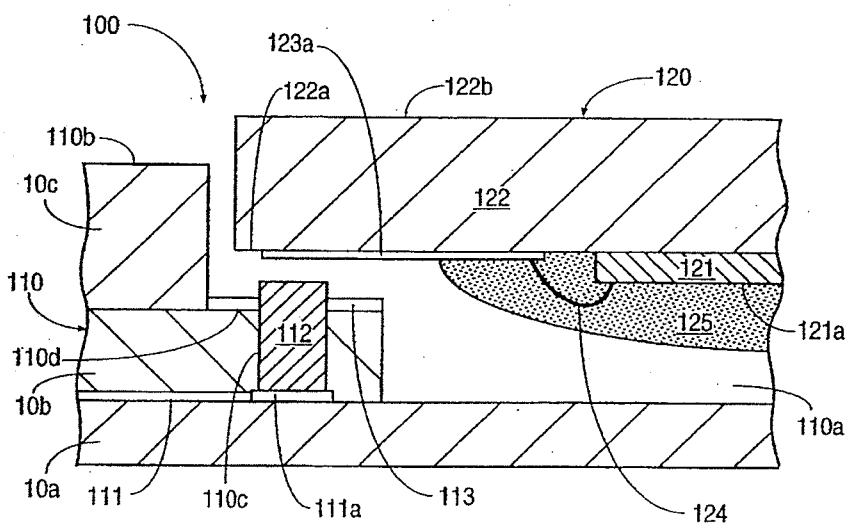
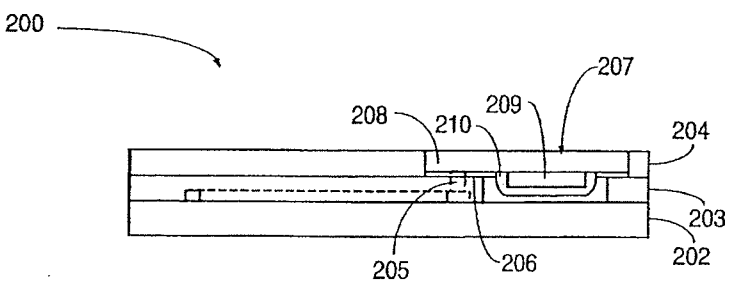
[57] **ABSTRACT**

A flexible structure includes two or more electronic and/or electromagnetic devices, electrical connection being made between the devices by flexible and compressible electrically conductive plugs located within cavities or holes formed within the flexible structure. The structure is assembled so that the plugs are compressed between electrical contacts formed on or connected to the respective devices. As a result, good electrical contact is maintained between the devices. Additionally, if the structure is flexible, when the flexible structure is bent or deformed, the plugs bend or deform with the rest of the flexible structure so that the electrical connections between the plugs and the respective device electrical contacts are not broken.

**12 Claims, 6 Drawing Sheets**



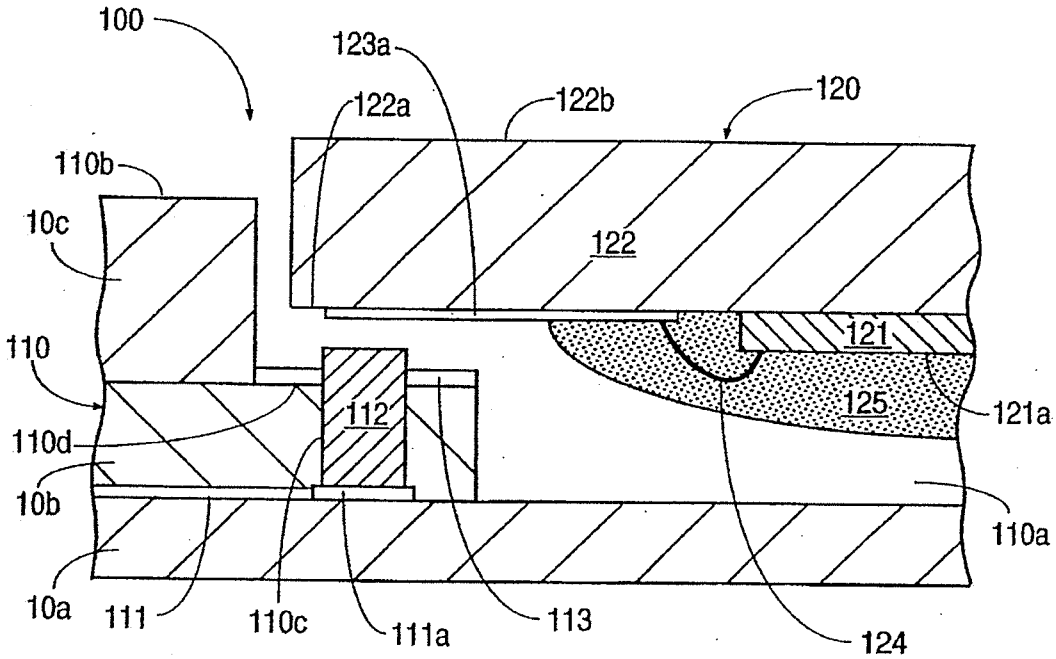
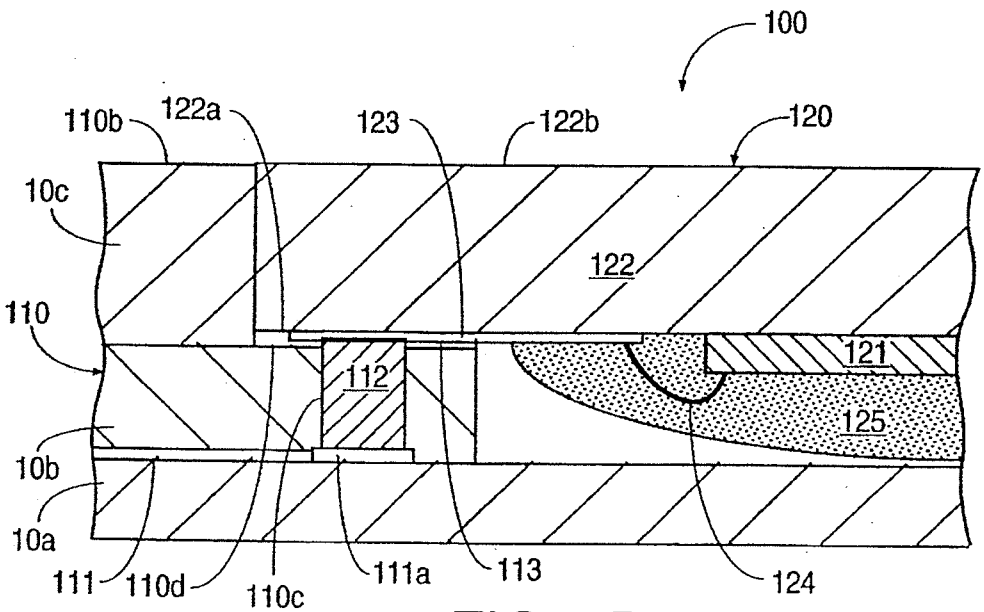

100
123a
122a
122b
120
110b
10c
122
110
121
112
125
121a
110d
10b
110a
10a
111
110c
111a
113
124

FIG. 1A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110b
122a
123
122b
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10a
111
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110c
111a
113
124

FIG. 1B

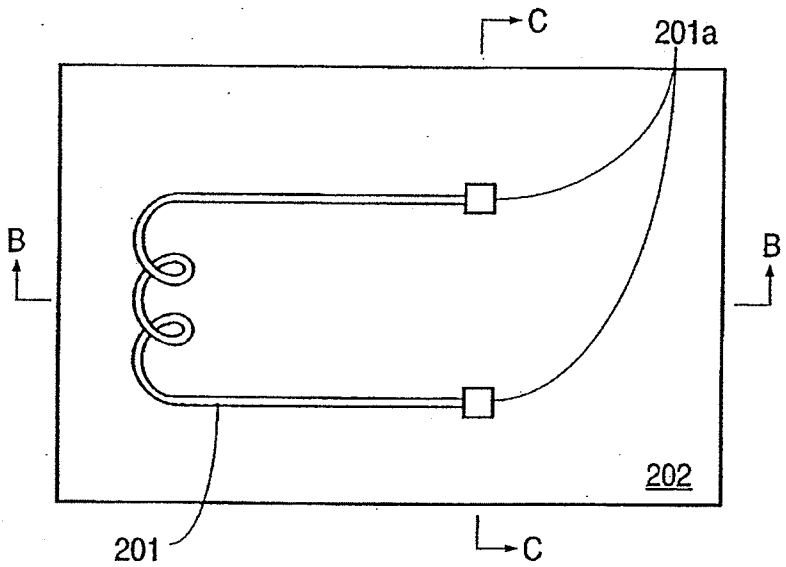


FIG. 2A

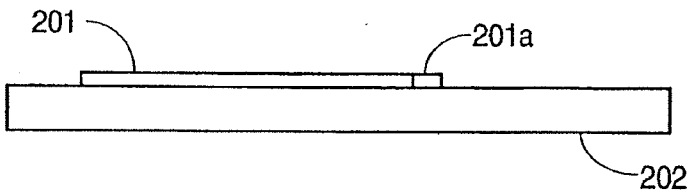


FIG. 2B

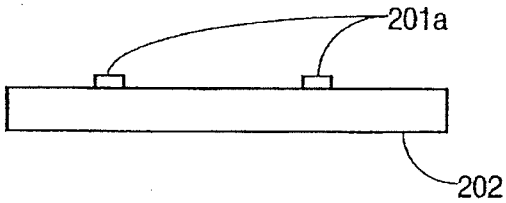


FIG. 2C

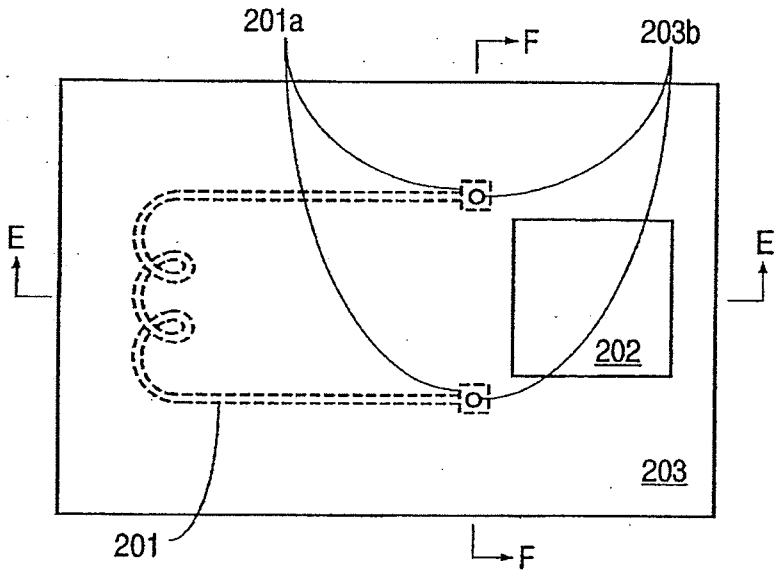


FIG. 2D

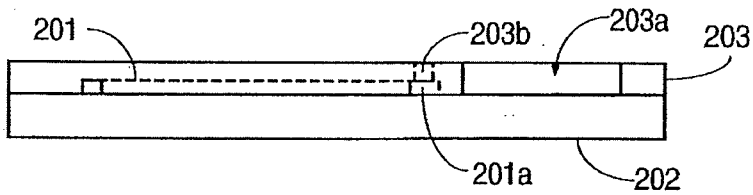


FIG. 2E

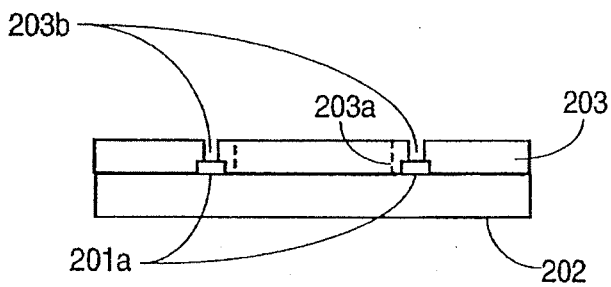


FIG. 2F

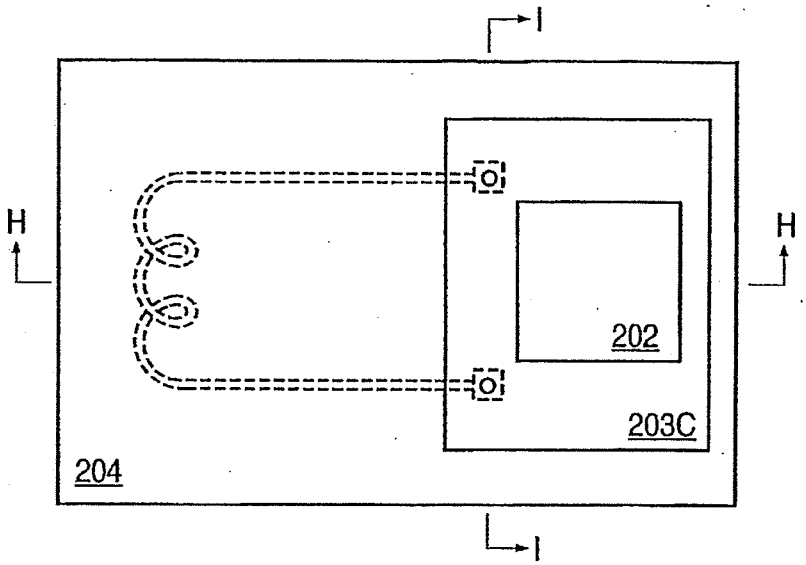


FIG. 2G

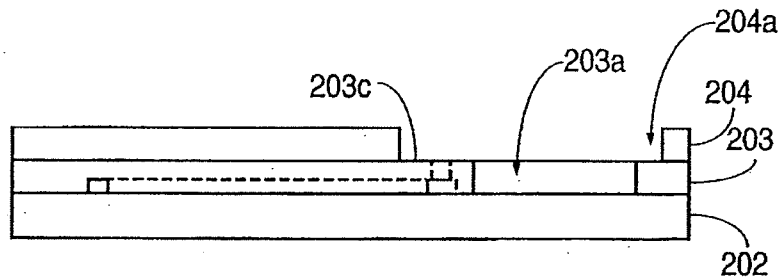


FIG. 2H

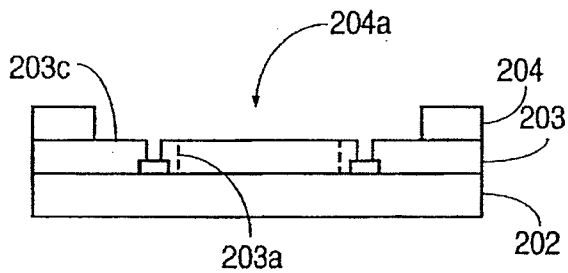


FIG. 2I

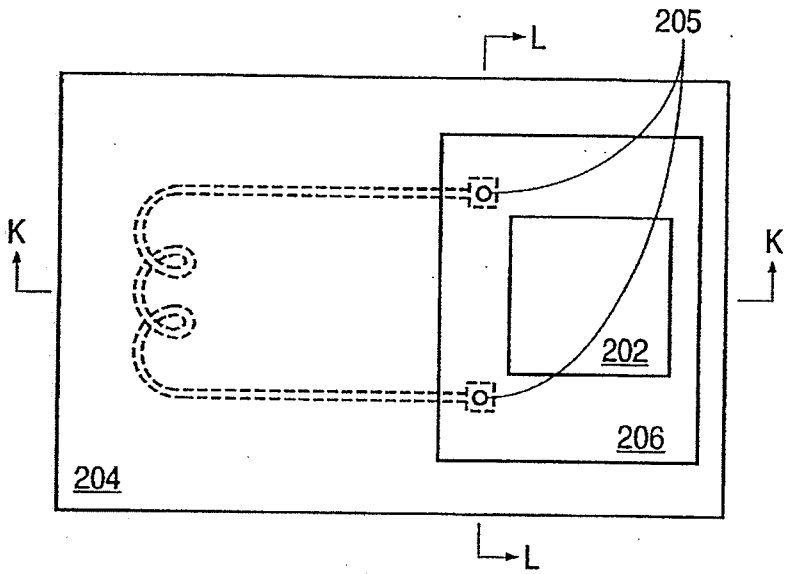


FIG. 2J

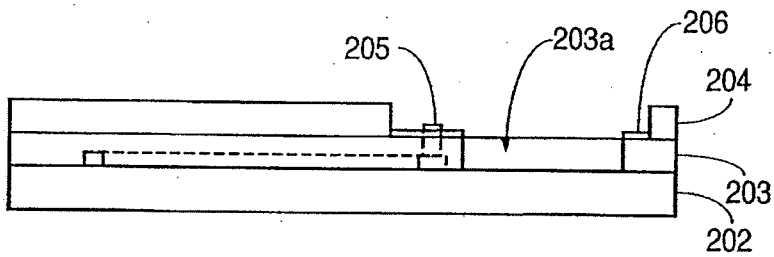


FIG. 2K

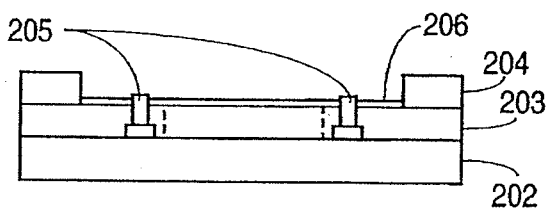


FIG. 2L

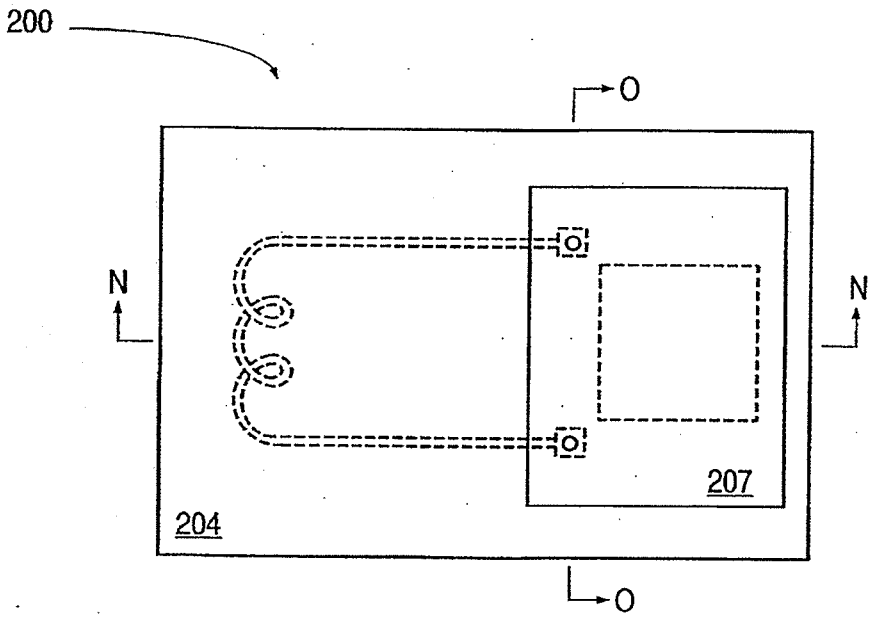


FIG. 2M

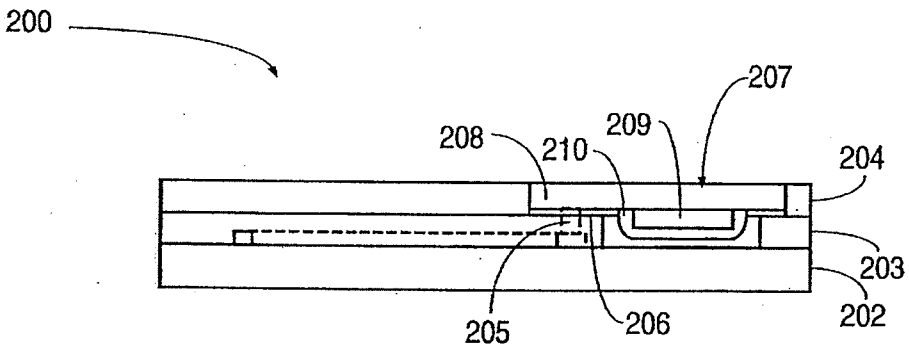


FIG. 2N

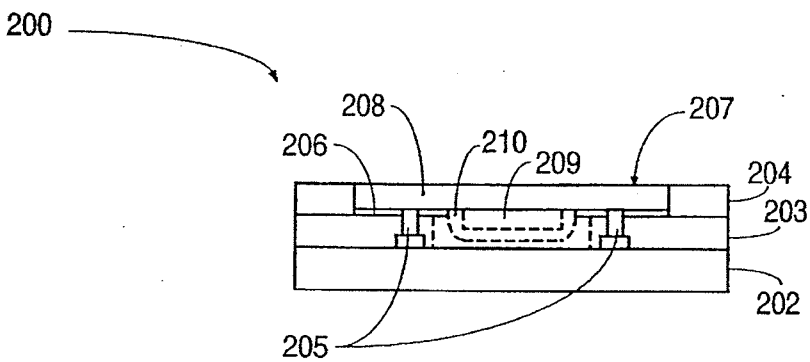


FIG. 2O

# ELECTRICAL INTERCONNECTION FOR STRUCTURE INCLUDING ELECTRONIC AND/OR ELECTROMAGNETIC DEVICES

## BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a flexible structure including electronic and/or electromagnetic devices and, in particular, to a contact structure for electrically connecting the devices so that electrical contact between the devices is maintained when the flexible structure is bent or otherwise deformed.

2. Related Art

There are a wide variety of applications that can make use of a flexible structure including electronic and/or electromagnetic devices, the devices being used for information input and output to and from the flexible structure, information processing and information storage. One example of such a flexible structure is a flexible identification card.

An identification card, as defined by the International Standards Organization (ISO) in ISO 7810, is "[a] card identifying its bearer and issuer which may carry data required as input for the intended use of the card and for transactions based thereon." Identification cards can have one of three nominal sizes (as specified in ISO 7810): 1) 3.370 inch (85.60 mm) width, 2.125 inch (53.98 mm) height, 0.030 inch (0.76 mm) thickness; 2) 4.134 inch (105 mm) width, 2.913 inch (74 mm) height, 0.030 inch (0.76 mm) thickness; 3) 4.921 inch (125 mm) width, 3.465 inch (88 mm) height, 0.030 inch (0.76 mm) thickness.

Some identification cards include an integrated circuit and are known as "integrated circuit cards" or "Smart Cards." More generally, herein, "Smart Card" refers to any portable card-like device which includes one or more electronic components, i.e., active components such as integrated circuits, transistors and diodes, and passive components such as resistors, capacitors and inductors. The integrated circuits can be formed on an integrated circuit chip and/or printed circuit board that is, in turn, attached to the main body of the Smart Card. Smart Cards can be used for a wide variety of applications such as prepaid "debit" cards (e.g., phone cards, transit passes, electronic purse), subscriber cards (e.g., bank ATM cards, credit cards, point-of-sale cards), loyalty scheme cards (e.g., frequent flier cards), security access and identification cards, health insurance and service cards (with optional protected memory), GSM (global system management for European Cellular Phones) cards and encryption/decryption cards.

Smart Cards are used with a reader/writer that includes an interface ("external interface") that is used to transmit information to or from the Smart Card. Some Smart Cards include electrical contacts which are used to make electrical connection between electrical circuitry on or within the Smart Card and the external interface. Other Smart Cards do not include electrical contacts and accomplish the transfer of information to and from the Smart Card through another means such as, for example, an inductive coil formed in or on the Smart Card that is used in combination with an external interface that produces and responds to an electromagnetic field, i.e., electromagnetic contact-less Smart Cards. Other types of contact-less cards use electro-static or capacitive coupling to accomplish the transfer of data and instructions to and from the card.

In Smart Cards (and other structures such as printed circuit boards, for example) including two or more electronic or electromagnetic devices, it is generally necessary



or desirable to electrically interconnect the devices. Typically, in Smart Cards, this is done within the main body of the Smart Card. Electrical interconnection is made between electrical contacts on the respective devices, e.g., electrically conductive traces on a printed circuit board, electrically conductive bond pads on an integrated circuit chip, terminal points of an inductive coil.

In some previous flexible structures including two or more electronic or electromagnetic devices, electrical interconnection has been made between the devices by soldering or welding the respective electrical contacts together, or by attaching the respective electrical contacts with an electrically conductive adhesive. However, when the flexible structure is bent, the relatively rigid (as compared to the flexible structure) solder, weld or adhesive can break, resulting in failure or degradation of the electrical interconnection. Further, soldering or welding the respective electrical contacts together is a difficult task since it is difficult to position the soldering or welding equipment within a cavity formed in the main body of the card for placing one of the devices, e.g., an integrated circuit module. Additionally, most flexible Smart Cards (as well as many other flexible structures) are made of low temperature plastic which undesirably melts at the temperatures necessary for soldering, welding or heating an adhesive.

In other previous flexible structures including two or more electronic or electromagnetic devices, electrical interconnection has been made by forming holes through the main body of the card, the holes extending between the respective electrical contacts of the devices, then inserting copper "studs" into the holes which are attached at either end to the respective electrical contacts by soldering, welding or use of an electrically conductive adhesive. However, when the flexible structure bends, the rigid copper studs do not, so that, frequently, one or more of the copper studs break away from one or both of the electrical contacts, thereby breaking the electrical interconnection between the devices.

## SUMMARY OF THE INVENTION

According to the invention, a structure includes two or more electronic and/or electromagnetic devices, electrical connection being made between the devices by flexible and compressible electrically conductive plugs located within cavities or holes formed within the flexible structure. The structure is assembled so that the plugs are compressed between electrical contacts formed on or connected to the respective devices. As a result, good electrical contact is maintained between the devices. Further, if the structure is a flexible structure, then, when the flexible structure is bent or deformed, the plugs bend or deform with the rest of the flexible structure so that the electrical connections between the plugs and the respective device electrical contacts are not broken.

Any number of electronic and/or electromagnetic devices can be included within the structure according to the invention, and the devices can be of any type such as an integrated circuit modules, transistors, diodes, and passive components such as resistors, inductors and capacitors. Further, an integrated circuit module for use with the invention can be a printed circuit board to which is attached one or more integrated circuit chips, a printed circuit board without an integrated circuit chip attached, or just an integrated circuit chip.

In one embodiment of the invention, the first device is an inductive coil supported by the main body of the structure and the second device is an integrated circuit module

including an integrated circuit chip attached to a printed circuit board, bond pads on the chip being wirebonded to electrically conductive traces or regions on the printed circuit board.

The plugs can be made of any flexible, compressible, electrically conductive material or combination of materials. In one embodiment, each of the plugs are a "Fuzz Button," i.e., a metallic conductor formed as, for instance, a group of knotted strands ("Fuzz"), or a set of parallel filaments, springs or platelets, enclosed in an elastomeric material such as Shin Etsu's Polymer MAF.

In certain embodiments of the invention, the structure is a "Smart Card". However, the invention applies broadly to any structure including electrically interconnected devices, such as printed circuit boards, and is particularly useful in such structures that are flexible.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1A** is a cross-sectional view of a portion of a structure according to an embodiment of the invention just prior to attachment of an integrated circuit module to the main body of the structure.

FIG. **1B** is a cross-sectional view of the portion of the structure of FIG. **1A** after attachment of the integrated circuit module to the main body of the structure.

FIGS. **2A** through **2O** illustrate steps in a process for forming a contact-less integrated circuit card according to an embodiment of the invention. FIGS. **2A**, **2B** and **2C** are a plan view, a cross-sectional view taken along section B—B of FIG. **2A**, and a cross-sectional view taken along section C—C of FIG. **2A**, respectively, illustrating an inductive coil formed on a surface of a first substrate that is part of the main body of a contact-less integrated circuit card. FIGS. **2D**, **2E** and **2F** are a plan view, a cross-sectional view taken along section E—E of FIG. **2D**, and a cross-sectional view taken along section F—F of FIG. **2D**, respectively, illustrating a second substrate that is formed on the first substrate to cover the inductive coil. FIGS. **2G**, **2H** and **2I** are a plan view, a cross-sectional view taken along section H—H of FIG. **2G**, and a cross-sectional view taken along section I—I of FIG. **2G**, respectively, illustrating a third substrate formed on the second substrate to define a mounting surface for an integrated circuit module on the second substrate. FIGS. **2J**, **2K** and **2L** are a plan view, a cross-sectional view taken along section K—K of FIG. **2J**, and a cross-sectional view taken along section L—L of FIG. **2J**, respectively, illustrating flexible, compressible electrically conductive plugs inserted in contact holes formed through the second substrate and an adhesive formed on the mounting surface of the second substrate. FIGS. **2M**, **2N** and **2O** are a plan view, a cross-sectional view taken along section N—N of FIG. **2M**, and a cross-sectional view taken along section O—O of FIG. **2M**, respectively, illustrating attachment of an integrated circuit module to the mounting surface of the second substrate so that electrical contact is made between the plugs and electrical contact points on the integrated circuit module.

## DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

According to the invention, a structure includes two or more electronic and/or electromagnetic devices, electrical connection being made between the devices by flexible and compressible electrically conductive plugs. The plugs are located within cavities or holes formed within the structure. The structure is assembled so that the plugs are compressed between electrical contacts formed on or connected to the respective devices.

Compression of the plugs results in a compressive force that pushes the plugs against the respective electrical contacts, thereby maintaining good electrical contact between the devices. Further, in structures according to the invention that are flexible, when the flexible structure is bent or otherwise deformed, the flexibility of the plugs allows the plugs to bend or deform with the rest of the flexible structure so that the electrical connections between the plugs and the respective device electrical contacts are not broken, thus preventing disablement of the electronic and/or electromagnetic capacity of the flexible structure.

FIG. **1A** is a cross-sectional view of a portion of a structure **100** according to an embodiment of the invention just prior to attachment of an integrated circuit module **120** to a main body **110** of the structure **100**. FIG. **1B** is a cross-sectional view of a portion of the structure **100** of FIG. **1A** after attachment of the integrated circuit module **120** to the main body **110** of the structure **100**.

In structure **100**, the integrated circuit module **120** is attached to the main body **110** which includes layers **10***a*, **10***b* and **10***c*, and an electrically conductive trace **111** (which may be an inductive coil). As described in more detail below in connection with FIGS. **2A–2O**, layers **10***a*, **10***b* and **10***c* are attached with an adhesive and/or laminated. It is to be understood that this embodiment is merely illustrative and that a wide range of combinations of electronic and/or electromagnetic devices can be used in a structure according to the invention. A structure according to the invention can include any kind and number of electronic and electromagnetic devices (e.g., integrated circuit modules, transistors, diodes, and passive components such as resistors, inductors and capacitors).

Further, the integrated circuit module **120** of structure **100** includes an integrated circuit chip **121** attached to a printed circuit board **122**. However, this need not be the case. An integrated circuit module for use with the invention could also be a printed circuit board without an integrated circuit chip attached, a printed circuit board with more than one integrated circuit chip attached, or just an integrated circuit chip.

The integrated circuit chip **121** is attached to the printed circuit board **122** using conventional techniques and adhesives. Electrically conductive traces **123** are formed on the printed circuit board **122** using conventional techniques. Any desired pattern of electrically conductive traces and electrically conductive regions (e.g., ground planes, power planes) can be formed on the surface **122***a* of the printed circuit board **122**. The electrically conductive traces **123** (and electrically conductive regions, if present) are made of any conventional printed circuit board metallization material. Bond pads (not shown) are formed on the surface **121***a* of the integrated circuit chip **121**. Each of selected ones of the bond pads are connected to a corresponding electrically conductive trace **123** by a bond wire **124** using conventional wirebonding techniques. The integrated circuit chip **121** is then encapsulated by a molding compound **125** by, for instance, potting.

The integrated circuit chip **121** can be attached to the printed circuit board **122** and electrically connected to the electrically conductive traces **123** other than as described above. For example, controlled collapse chip connection can be used to directly attach the bond pads of the integrated circuit chip **121** to the electrically conductive traces **123** of the printed circuit board **122** so that the surface **121***a* of the

integrated circuit chip **121** is adjacent the surface **122***a* of the printed circuit board **122**.

Additionally, the integrated circuit chip **121** can be attached to a leadframe or a set of leads on TAB tape and the leads attached to the main body **110**.

The main body **110** is formed with a cavity **110***a* in which the integrated circuit module **120** fits such that the surface **122***b* of the printed circuit board **122** is substantially planar with the surface **110***b* of the main body **110** (see FIG. 1B) when the integrated circuit module **120** is attached to the main body **110**. The electrically conductive trace **111** is formed of, for example, copper plated with nickel and gold, and has electrical contact pads **111***a* at terminal ends. The contact pads **111***a* are formed of, for example, copper plated with nickel and gold, and are positioned at locations that correspond to the locations of electrically conductive traces **123** on the printed circuit board **122**. Each of a plurality of holes **110***c* are formed through the main body **110** to extend from one of the contact pads **111***a* to a mounting surface **110***d* of the main body **110**. An adhesive **113** is formed on the mounting surface **110***d* so that the adhesive **113** does not cover the holes **110***c*. An electrically conductive plug **112** is placed within each hole **110***c* such that the plug **112** extends above the adhesive **113** (FIG. 1A) before attachment of the integrated circuit module **120** to the main body **110**. Although only one conductive trace **111**, contact pad **111***a*, hole **110***c* and conductive trace **123** are illustrated in FIGS. 1A and 1B, it will be appreciated that a plurality may be used, for example, as illustrated in FIGS. 2A through 2O.

As seen in FIG. 1B, when the integrated circuit module **120** is attached to the main body **110**, the plugs **112** are compressed. (Though, in FIG. 1A, the plug **112** is shown as having the same diameter as the hole **110***c*, in practice, the plug **112** must have a slightly smaller diameter to accommodate the compression of the plug **112** which expands the plug **112** to increase the diameter of the plug **112**.) The adhesive **113** holds the integrated circuit module **120** in place within the cavity **110***a* in the main body **110** so that the plugs **112** remain compressed after formation of the structure **100** is complete.

The plugs **112** are made of any flexible, compressible, electrically conductive material or combination of materials, as described in more detail below. Thus, compression of the plugs **112** causes a compressive force in the plugs **112** that presses the plugs **112** against the electrically conductive traces **123** and the contact pads **111***a* so that good electrical contact is maintained. Further, since the plugs **112** are made of an elastomeric material, if the structure **100** is flexible, when the structure **100** is bent or otherwise deformed, the plugs **112** bend or deform also, reducing stresses at the interface between the plug **112** and the electrically conductive trace **123**, and the interface between the plug **112** and the contact pad **111***a*. Thus, bending of the structure **100** does not cause the plugs **112** to break away from either the electrically conductive traces **123** or the contact pads **111***a*, so that the electronic and/or electromagnetic functions of the structure **100** are not disabled.

FIGS. 2A through 2O illustrate steps in a process for forming an electromagnetic contact-less integrated circuit card according to an embodiment of the invention. However, it is to be understood that the invention is applicable to any type of structure including two or more electronic and/or electromagnetic devices and that the process described is merely illustrative of the possible processes for forming a structure according to the invention.

FIGS. 2A, 2B and 2C are a plan view, a cross-sectional view taken along section B—B of FIG. 2A, and a cross-sectional view taken along section C—C of FIG. 2A, respectively, illustrating an inductive coil **201** formed on a surface of a first substrate **202** that is part of the main body of an electromagnetic contact-less integrated circuit card. In FIGS. 2A, 2B, 2C (and FIGS. 2D through 2O below), for simplicity, the inductive coil **201** is shown schematically using the well known symbol for an inductor. It is to be understood that, in reality, the inductive coil **201** can be formed in any appropriate shape. In one embodiment, the inductive coil **201** is formed as a spiral. The spiral is formed in three dimensions such that the outer "end" of the spiral and the inner "end" of the spiral are in different planes so that the inner "end" of the spiral can be extended to a contact pad (described in more detail below) located outside of the outermost turn of the spiral.

The first substrate **202** is formed of any suitable material. In embodiments in which the structure according to the invention is flexible, the first substrate **202** is formed of one or more layers of a flexible material such as, for example, poly-vinyl-chloride, polyimide, FR4 (fiberglass), bituminous resin, polysulfone, polycarbonate or ABS (acrylonitrile-butadiene-styrene). If desired, different materials can be used for different layers of the substrate **202**. The number and types of materials of layers included in the first substrate **202** (and the other substrates described below) depends upon the manufacturing techniques used, the characteristics of the material being used and the mechanical performance requirements of the electromagnetic contact-less integrated circuit card.

If more than one layer is used for the first substrate **202**, preferably, the layers are attached with adhesives and then laminated (i.e., fused together under heat and pressure to form a unitary structure). Any of a number of different adhesives can be used, such as rubber-based adhesives, solvent and latex based adhesives, thermoplastic hot melt, iscoyanate-based adhesives, PUR (polyurethanes), epoxy resin, polysulfide sealants and adhesives, reactive acrylate-based adhesives, cyanoacrylates and silicones. However, the layers need not be laminated and can be attached only with adhesives. Alternatively, if the layers are laminated, the layers need not be first attached with an adhesive.

The inductive coil **201** is formed in or on the surface of the first substrate **202** with a shape and of a material determined according to principles well-known in the art of coil forming. For example, inductive coil **201** can be formed in a spiral, as described above, of any desired electrically conductive material such as, for example, copper. Inductive coil **201** is formed using any of a number of conventional processes and equipment that are well known in the art of coil forming. For example, inductive coil **201** can be formed using conventional lithographic techniques.

The contact pads **201***a* are formed at terminal ends of the inductive coil **201**. The contact pads **201***a* can be formed by, for example, stamping the terminal ends of inductive coil **201**. Alternatively, contact pads **201***a* can be attached to the terminal ends of inductive coil **201** by, for example, spot welding or soldering. The contact pads **201***a* can be made of, for example, copper, stainless steel, nickel or brass. The contact pads **201***a* can be plated with gold, if desired.

FIGS. 2D, 2E and 2F are a plan view, a cross-sectional view taken along section E—E of FIG. 2D, and a cross-sectional view taken along section F—F of FIG. 2D, respectively, illustrating a second substrate **203** that is formed on the first substrate **202** to cover the inductive coil **201**. Like the first substrate **202**, the second substrate **203** can include one or more layers. The layers of the second substrate **203**

are made of materials as described above and can be different from each other and/or different from the layers of the first substrate **202**. The second substrate **203** is attached to the first substrate **202** with an adhesive and laminated, just attached with an adhesive, or just laminated.

Contact holes **203***b* are formed through the second substrate **203** at locations that correspond to the location of the contact pads **201***a* of the inductive coil **201**. A cavity hole **203***a* into which an integrated circuit module will be positioned is also formed through the second substrate **203**. The contact holes **203***b* and cavity hole **203***a* can be formed either before or after attaching the second substrate **203** to the first substrate **202**. The contact holes **203***b* and cavity hole **203***a* can be formed by, for instance, punching, stamping, chemical etching, mechanical or laser drilling, or milling.

FIGS. 2G, 2H and 2I are a plan view, a cross-sectional view taken along section H—H of FIG. 2G, and a cross-sectional view taken along section I—I of FIG. 2G, respectively, illustrating a third substrate **204** formed on the second substrate **203** to define a mounting surface **203***c* for an integrated circuit module on the second substrate **203**. Like the first substrate **202** and second substrate **203**, the third substrate **204** can include one or more layers. The layers of the third substrate **204** are made of materials as described above and can be different from each other and/or different from the layers of the first substrate **202** and/or second substrate **203**. The third substrate **204** is attached to the second substrate **203** with an adhesive and laminated, just attached with an adhesive, or just laminated.

A cavity hole **204***a* is formed through the third substrate **204** at a location such that, when the third substrate **204** is attached to the second substrate **203**, the cavity hole **204***a* defines a shelf **203***c* on a surface of the second substrate **203** that surrounds the cavity hole **203***a* formed through the second substrate **203**. The cavity hole **204***a* can be formed either before or after attaching the third substrate **204** to the second substrate **203**. The cavity hole **204***a* can be formed by, for instance, punching, stamping, chemical etching, mechanical or laser drilling, or milling.

FIGS. 2J, 2K and 2L are a plan view, a cross-sectional view taken along section K—K of FIG. 2J, and a cross-sectional view taken along section J—J of FIG. 2J, respectively, illustrating flexible, compressible electrically conductive plugs **205** inserted in the contact holes **203***b* and an adhesive **206** formed on the mounting surface **203***c* of the second substrate **204**. Insertion of the plugs **205** into the contact holes **203***b* and formation of the adhesive **206** on the mounting surface **203***c* can occur in any order. In another embodiment of the invention, an electrically conductive adhesive is formed on opposite ends of the plugs **205** to help adhere the plugs **205** to the contact pads **201***a* and to electrical contact points formed on the integrated circuit module **207** (discussed in more detail below).

The adhesive **206** can be a liquid glue, e.g., a cyanoacrylic glue such as Locktite, which is dispensed on to mounting surface **203***c* using conventional equipment and processes. The glue dispensing equipment is controlled (either manually or by computer-controlled robotic dispenser) so that glue does not enter the contact holes **203***b* (if the adhesive **206** is formed before insertion of the plugs **205**) or contact the plugs **205** (if the adhesive **206** is formed after insertion of the plugs **205**).

Alternatively, adhesive **206** can be a solid material, e.g., double-sided sticky tape. The solid material is patterned with holes and a cavity that correspond to the contact holes **203***b* and cavity **203***a*, then adhered to mounting surface **203***c*.

Or, adhesive **206** can be a thermosetting resin such as epoxy resin. The thermosetting resin can be patterned with holes and a cavity, as above, and placed on mounting surface **203***c*, or the thermosetting resin can be dispensed on to mounting surface **203***c*. The thermosetting resin is then heated and cooled after the integrated circuit module is placed within cavities **203***a* and **204***a*, as explained below.

The plugs **205** are placed either robotically or manually in the contact holes **203***b* using conventional tools and processes. In the electromagnetic contact-less integrated circuit card according to the invention shown in FIGS. 2A through 2O, there are two contact holes **203***b* and plugs **205**, one at each terminal end of the inductive coil **201**. However, it is to be understood that in other embodiments of a structure according to the invention including other types or quantities of electronic or electromagnetic devices, a lesser or greater number of contact holes **203***b* and plugs **205** can be formed. Further, even in the electromagnetic contact-less integrated circuit card shown in FIGS. 2A through 2O, it is possible and perhaps desirable to form additional, redundant sets of contact pads **201***a*, contact holes **203***b* and plugs **205** to increase the reliability of the electromagnetic contact-less integrated circuit card.

The plugs **205** and contact holes **203***b* are shown in FIGS. 2D through 2O as having a circular cylindrical shape. However, cylindrical shapes having other cross-sectional shapes, e.g., rectangular, can be used. The height of the plugs **205** is chosen to be slightly greater than the combined thickness of the second substrate **203** and the adhesive **206**, so that when the integrated circuit module is attached, as explained below, the plugs **205** are compressed. Further, the cross-sectional dimensions of the plugs **205**, e.g., diameter, or width and length, are made slightly smaller than the corresponding dimensions of the contact holes **203***b* so that, when the plugs **205** are compressed, there is room within the contact holes **203***b* for the plugs **205** to expand.

As noted above, the plugs **205** can be formed of any flexible, compressible, electrically conductive material or combination of materials. In one embodiment, the plugs **205** are made of an anisotropically electrically conductive elastomeric material. In a further embodiment, the plugs **205** are a metallic conductor enclosed in an elastomeric material such as, for example, an intrinsically conductive polymer (ICP). The metallic conductor is, for instance, a group of knotted strands, or a set of parallel filaments, springs or platelets. The plugs **205** according to this embodiment of the invention are either molded, extruded and cut, or die punched. Plugs **205** according to this embodiment of the invention are commercially available as "Fuzz Buttons" from Trw/Cinch located in Elk Grove Village, Ill. Plugs **205** can also be polymer MAF available from Shin Etsu Polymer America located in Union City, Calif. Whatever material is used for plugs **205**, it is necessary or desirable to specify certain characteristics of plugs **205**: electrical properties such as, for example, resistance and, where appropriate,

inductance; geometric dimensions; and mechanical properties such as, for example, spring constant.

FIGS. 2M, 2N and 2O are a plan view, a cross-sectional view taken along section N—N of FIG. 2M, and a cross-sectional view taken along section O—O of FIG. 2M, respectively, illustrating attachment of an integrated circuit module **207** to the mounting surface **203***b* of the second substrate **203** so that electrical contact is made between the plugs **205** and electrical contact points (not shown) on the integrated circuit module **207**. The electrical contact points can be either a portion of an electrically conductive trace, or an electrically conductive contact pad formed at the end of an electrically conductive trace. Attachment of the integrated circuit module **207** completes formation of the electromagnetic contact-less integrated circuit card **200**.

The integrated circuit module **207** includes a conventional integrated circuit chip **209** attached to a conventional printed circuit board **208** (e.g., an FR4 printed circuit board with metallization made of copper plated with nickel and gold) and enclosed by an encapsulant **210**. The integrated circuit chip **209** is attached to the printed circuit board **208** using conventional adhesives. Bond pads (not shown) on the integrated circuit chip **209** are electrically connected with bond wires (not shown) to electrically conductive traces and/or regions formed on a surface of the printed circuit board **208** using conventional wirebonding techniques. The encapsulant **210** is formed by potting to enclose the integrated circuit chip **209** and bond wires. However, note that formation of encapsulant **210** is not absolutely necessary and, in other embodiments of the invention, the encapsulant **210** is not present.

The integrated circuit module **207** is positioned within the cavities **203***a* and **204***a* on the adhesive **206**, either manually or robotically using conventional equipment and processes, so that each of the electrical contact points on the printed circuit board **208** contacts a corresponding one of the plugs **205**. Pressure is applied to the integrated circuit module **207** so that the plugs **205** are compressed. If a thermosetting resin is used as adhesive **206**, the resin is heated and then cooled while the pressure is applied. The adhesive **206** holds the integrated circuit module **207** in place, keeping the plugs **205** compressed so that good electrical contact is maintained between each of the plugs **205** and the corresponding contact pad **201***a* and electrical contact point of the printed circuit board **208**.

In embodiments of a structure according to the invention other than that shown in FIGS. 2A through 2O, electrically conductive circuitry and regions can be formed in any desired pattern according to well known techniques on one or more of the layers of the main body. Vias may also be formed according to well known techniques through one or more layers of the main body to electrically connect electrically conductive material formed on different layers of the main body.

Various embodiments of the invention have been described. The descriptions are intended to be illustrative, not limitative. Thus, it will be apparent to one skilled in the art that certain modifications may be made to the invention as described without departing from the scope of the claims set out below.

I claim:

**1**. A smart card comprising:

a first flexible layer;

a first electrical contact located over a first surface of the first layer;

a first electronic or electromagnetic device for controlling said smart card disposed on the first layer, wherein the first electrical contact is coupled to the first device;

a second flexible layer located over the first surface of the first layer and the first electrical contact, the second layer having an opening which extends through the second layer to expose the first electrical contact, and wherein a cavity is formed in the second layer;

a third layer located over the second layer;

a second electrical contact located over the third layer, the second and third layers being positioned such that the second electrical contact is disposed between the second and third layers, and over the opening;

a second electronic or electromagnetic device for controlling said smart card disposed on the third layer, wherein the second electrical contact is coupled to the second device, and wherein the second device is disposed in the cavity in the second layer; and

a flexible, compressible electrically conductive plug located within the opening, the plug being compressed between the first electrical contact and the second electrical contact to make electrical connection therebetween.

**2**. The smart card of claim **1**, wherein the second device is an integrated circuit module.

**3**. Structure as in claim **2**, wherein the integrated circuit module further comprises an integrated circuit chip.

**4**. The smart card of claim **3**, wherein the third layer comprises a printed circuit board.

**5**. The smart card of claim **4** further comprising:

an electrically conductive trace located on a surface of the printed circuit board, wherein the trace is electrically connected to the second electrical contact;

an electrically conductive bond pad located on a surface of the integrated circuit chip; and

means for electrically connecting the bond pad to the trace on the printed circuit board.

**6**. The smart card of claim **2**, wherein the first device is an inductive coil fabricated over the first surface of the first layer.

**7**. The smart card of claim **1**, wherein the plug is made of an anisotropically electrically conductive elastomeric material.

**8**. The smart card of claim **7**, wherein the plug is a fuzz button.

**9**. The smart card of claim **1**, further comprising a flexible fourth layer located over the second layer, wherein the fourth layer has an opening which laterally surrounds said third layer.

**10**. A method for constructing a smart card, the method comprising the steps of:

providing a first flexible layer;

forming a first electrically conductive trace over a first surface of the first flexible layer, the first trace having a first electrical contact;

affixing a first electronic or electromagnetic device over the first surface of the first layer, whereby the first device is coupled to the first trace;

providing a second flexible layer;

forming an opening through the second flexible layer;

forming an cavity in the second flexible layer;

placing an flexible, compressible, electrically conductive plug in the opening;

affixing the second layer to the first layer such that the opening is aligned with the first electrical contact;

providing a third layer;

forming a second electrically conductive trace over a second surface of the third layer, the second trace having a second electrical contact;

affixing a second electronic or electromagnetic device over the second surface of the third layer, whereby the second device is coupled to the second trace;

affixing the third layer to the second layer, such that the opening is aligned with the second electrical contact, the second device is disposed in the cavity, and the plug is compressed between the first and second electrical contacts.

**11**. A method as in claim **10**, wherein the first device comprises an inductive coil.

**12**. A method as in claim **10**, wherein the the second device is an integrated circuit module.

* * * * *

# United States Patent [19]

**Lyszczarz**

[11] **Patent Number: 4,897,533**

[45] **Date of Patent: Jan. 30, 1990**


[54] **CREDIT CARD AND METHOD OF MAKING THE SAME**


[75] Inventor: **John L. Lyszczarz**, Edison, N.J.

[73] Assignee: **National Business Systems, Inc.**, Ontario, Canada



[21] Appl. No.: **79,921**

[22] Filed: **Jul. 31, 1987**

**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 70,714, Jul. 7, 1987, abandoned.

[51] **Int. Cl.**[4] ..... **G06K 19/00**

[52] **U.S. Cl.** ..... **235/487**; 235/488; 235/493; 283/904

[58] **Field of Search** ..... 235/454, 488, 487, 493; 283/91, 109, 904, 111; 428/916



[56] **References Cited**

U.S. PATENT DOCUMENTS

| | | | |
|---|---|---|---|
| 3,494,818 | 2/1970 | Marchese . | |
| 3,809,568 | 5/1974 | Askew . | |
| 3,812,328 | 5/1974 | Tramposch | 235/488 X |
| 4,022,943 | 5/1977 | Erb et al. . | |
| 4,072,592 | 2/1978 | Dué et al. | 428/511 X |
| 4,318,554 | 3/1982 | Anderson et al. . | |
| 4,479,995 | 10/1984 | Suzuki et al. . | |
| 4,575,127 | 3/1986 | Michel . | |
| 4,642,959 | 2/1987 | Swiech, Jr. et al. . | |
| 4,659,112 | 4/1987 | Reiner et al. | 283/904 X |
| 4,671,839 | 6/1987 | Finkel et al. | 235/488 X |
| 4,673,626 | 6/1987 | Takeda et al. . | |
| 4,680,459 | 7/1987 | Drexler | 235/454 X |
| 4,684,795 | 8/1987 | Colgate | 235/488 X |
| 4,686,133 | 8/1987 | Nakabayashi et al. . | |
| 4,692,402 | 9/1987 | Bouldin et al. | 430/945 |
| 4,745,268 | 5/1988 | Drexler | 235/454 X |

FOREIGN PATENT DOCUMENTS

| | | |
|---|---|---|
| 20031521 | 7/1981 | European Pat. Off. . |
| 0210619 | 7/1986 | European Pat. Off. . |
| 632482 | 7/1970 | Fed. Rep. of Germany . |
| 12532935 | 2/1976 | Fed. Rep. of Germany . |
| 5657574 | 9/1986 | Liechtenstein . |
| 1264712 | 2/1972 | United Kingdom . |



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[57] **ABSTRACT**

An improved credit card having a clear, unbroken metallized surface with printed graphics thereon which is scratch resistant and a method of making the same are disclosed. The method involves heat transferring a metallized foil to a first surface of a plastic substrate, silk-screen printing over the metallized foil with ultraviolet curable ink, drying the ink with ultraviolet light and overlaminating the printed foil with a clear polyester film coated with a heat-activated adhesive or coating it with an ultraviolet curable varnish which is cured by applying ultraviolet light to the coating. The plastic substrate is in the form of a large sheet from which a plurality of cards are die cut after the printing and application of the transparent film. A magnetic tape is then applied to the back of each card.


**24 Claims, 3 Drawing Sheets**

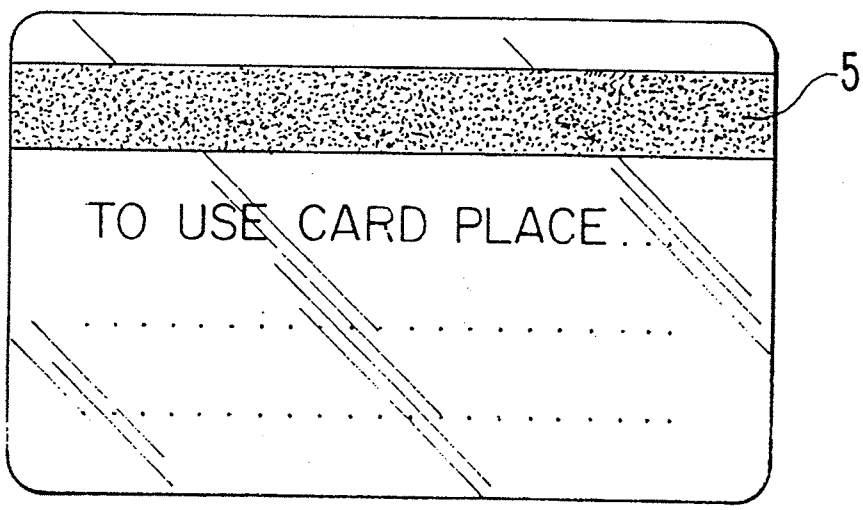


FIG. 1

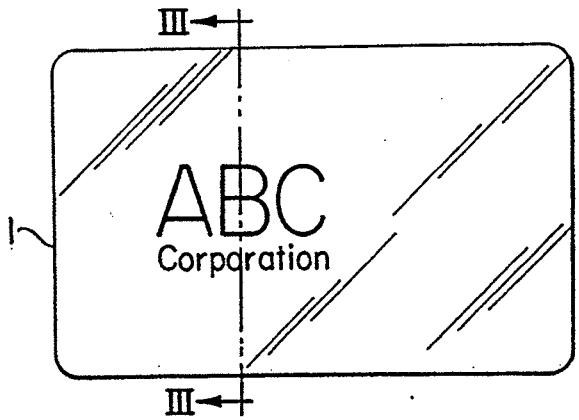



FIG. 2

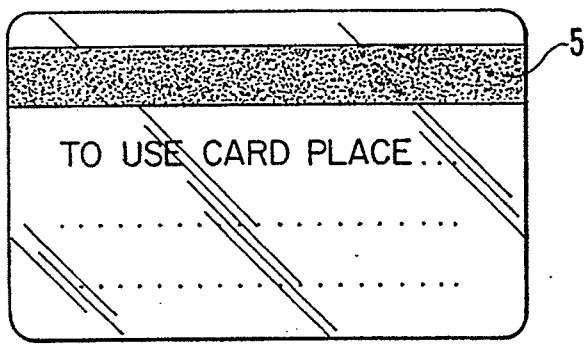



FIG. 3

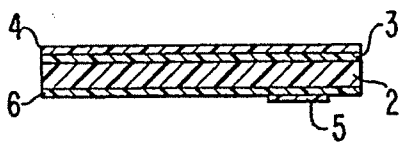


FIG. 4

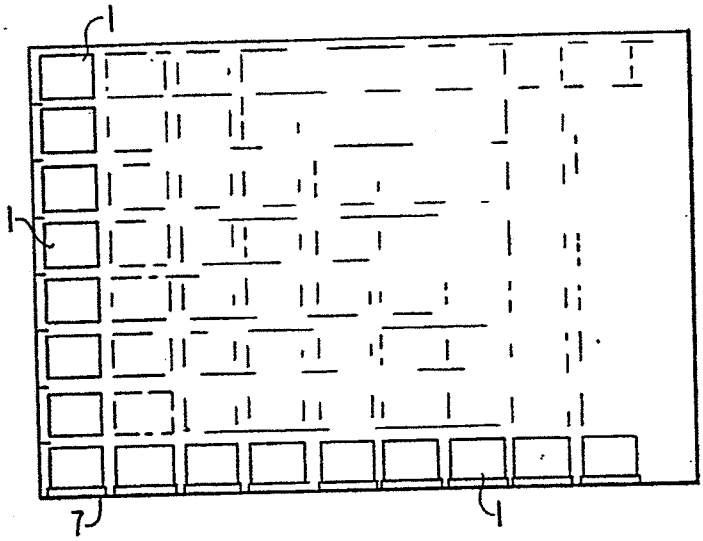



FIG. 5

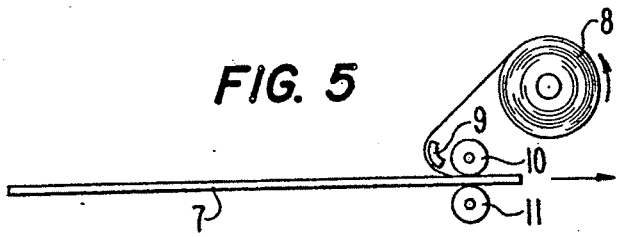
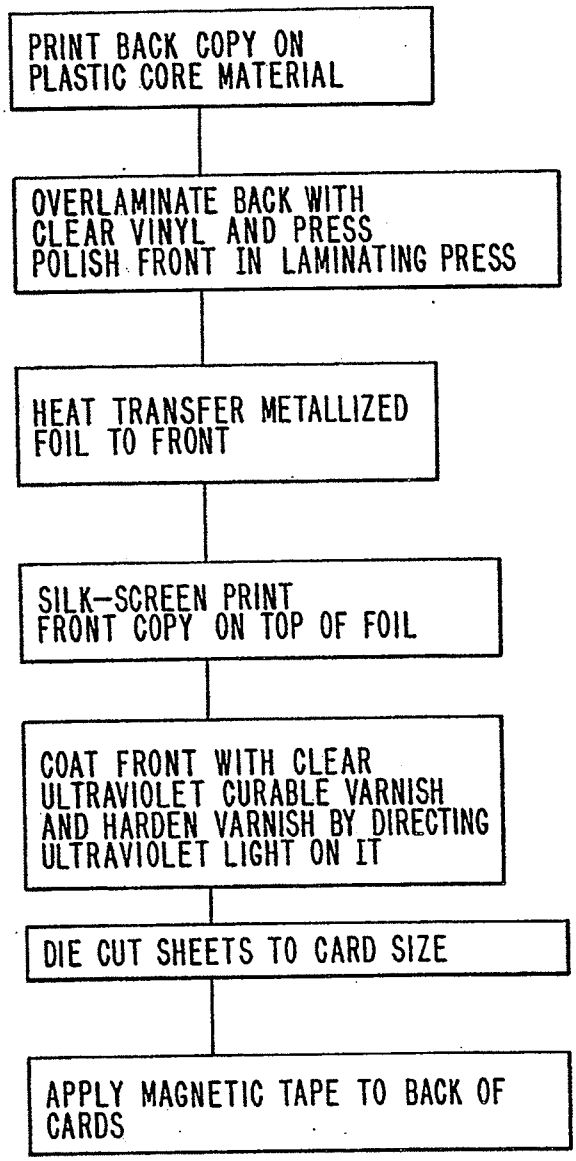


FIG. 6


PRINT BACK COPY ON PLASTIC CORE MATERIAL
OVERLAMINATE BACK WITH CLEAR VINYL AND PRESS POLISH FRONT IN LAMINATING PRESS
HEAT TRANSFER METALLIZED FOIL TO FRONT
SILK-SCREEN PRINT FRONT COPY ON TOP OF FOIL
COAT FRONT WITH CLEAR ULTRAVIOLET CURABLE VARNISH AND HARDEN VARNISH BY DIRECTING ULTRAVIOLET LIGHT ON IT
DIE CUT SHEETS TO CARD SIZE
APPLY MAGNETIC TAPE TO BACK OF CARDS

# CREDIT CARD AND METHOD OF MAKING THE SAME

## REFERENCE TO RELATED APPLICATION

This is a continuation-in-part application of U.S. Application Ser. No. 070,714 filed July 7, 1987, now abandoned.

## BACKGROUND AND SUMMARY OF THE INVENTION

The present invention is directed to an improved credit card and method of making the same. The credit card has a clear, scratch resistant metallic surface.

The use of credit cards has become increasingly wide spread. Efforts have been made to provide these cards with attractive, distinctive appearances to identify and promote the company or other entity issuing the cards. Recently, the application of holographics to credit cards has been popular for these reasons. The attractiveness of a metallic surface is generally recognized but such surfaces with printed graphics would be readily scratched and lose their attractiveness on a credit card with normal use of the card.

It is known to apply a clear vinyl film such as PVC over the printing on the white vinyl core, also of PVC, of a credit card under heat and pressure in a hydraulic laminating press to protect the surface of the card including the printing thereon. However, heretofore it has not been possible to apply such a protective film over a metallic surface applied on the plastic core of a credit card without encountering problems in breakage of the thin metallized surface and/or lack of clarity in the overlaminate. Conventional offset lithography printing of a thin metallized surface on a thin plastic substrate such as a credit card is also not practical, especially in an automated process, since the details of the graphics, e.g., fine lines etc., tend to blur. Processing a laminate of a plastic substrate with a metallized surface is also problematical because the laminate in effect becomes a capacitor for storing static electricity generated during processing such as printing.

An object of the present invention is to provide an improved credit card and a method of making the same which avoid the aforementioned problems. More particularly, an object of the invention is to provide a credit card and a method of making the same whereby the card has an attractive scratch resistant metallic surface which remains unbroken during manufacturing. Another object is to provide a protected metallized surface on a credit card which is clearly visible. A further object of the invention is to provide a method of forming a credit card having a protected metallized surface wherein clearly legible printed information can be readily provided on the metallized surface of the card.

These and other objects are attained by the method of making a credit card with a scratch resistant metallic surface according to the invention, the method comprising the steps of providing a plastic substrate, providing a metal containing layer on at least a first surface of the plastic substrate and providing the metal containing layer with a transparent film to protect the metal containing layer without breaking the layer. The metal containing layer is preferably in the form of a metallic foil which is bonded to the first surface of the plastic substrate during the applying step. One side of the foil is initially adhered to a thin film carrier via a release agent.



An outer, opposite side or surface of the foil to be bonded to the first surface of the plastic substrate is coated with a heat-activated adhesive. The foil is bonded to the first surface of the plastic substrate under the application of heat and pressure in a hydraulic laminating press, for example, to adhesively bond the foil to the first surface of the plastic substrate and release the foil from the carrier film. The first surface of the substrate is press polished prior to transferring the metal containing layer thereon.

The metal containing layer provided on the first surface of the plastic substrate is printed to form graphics, e.g., letters, pictures, etc., before the transparent film is provided thereon. According to the method of the invention the graphics are printed by silk-screen printing on the metal containing layer using with an ultraviolet curable ink which is cured immediately after being applied to the layer by directing ultraviolet light on the ink. The method further includes the step of eliminating static electricity from the layer and plastic substrate during the printing to facilitate the printing operation. This is accomplished by the application of ionized air to the plastic substrate and metallized layer and the provision of grounded, conductive tinsel near the substrate in the printing apparatus.

According to the disclosed embodiment, the transparent film is provided on the metal containing layer by coating the printed metal containing layer with an ultraviolet curable varnish and curing the varnish by directing ultraviolet light on it. Alternatively, the transparent film can be a clear polyester film which is adhesively bonded to the metal-containing layer using a clear heat-activated adhesive, particularly a polyethylene adhesive. More particularly, the heat-activated adhesive on a surface of the clear polyester film is heated and then bonded to the first surface of the plastic substrate by conveying the substrate and film between opposed nip rollers to press the film against the metal containing layer on the substrate.

The plastic substrate is preferably in the form of a large sheet containing a plurality of credit cards. The individual credit cards are die cut to card size from the sheet after the step of providing the metal containing layer with the transparent film. Identifying information means is then located on each card. In the disclosed form of the invention, the identifying information means is a magnetic tape which is attached to the card on a second surface of the plastic substrate opposite the first surface of the substrate by a known hot stamping process, a roll or heat transfer process or a laminating process.

The improved credit card made by the method of the present invention comprises a plastic substrate in the form of a card, a metal containing layer having printed graphics thereon overlayed on at least one surface of the plastic substrate and a transparent film over the metal containing layer. The metal containing layer is bonded to the first surface of the substrate and preferably covers at least substantially the entire first surface of the substrate. The metal containing layer is a metallic foil formed from aluminum or an aluminum alloy, for example, which may be colored to have a gold, silver, red, green, blue or other colored appearance. The transparent film which is bonded to the metal containing layer is preferably a clear, ultraviolet cured varnish. In the disclosed form of the invention, the metal containing layer has printed graphics in ultraviolet curable ink

silk screened thereon beneath the transparent film on the metal containing layer. A second surface of the substrate opposite the first surface also bears printed graphics and is overlayed with a transparent vinyl film with a magnetic tape being attached thereto for carrying identifying information.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a front side of a credit card according to a preferred embodiment of the invention, the front surface of the card having a scratch resistant metallic surface having printed information thereon;

FIG. 2 is a plan view of the back side of the credit card of FIG. 1 wherein a magnetic tape and printed information are provided;

FIG. 3 is a cross-sectional view of the credit card of FIG. 1 taken along the line III—III and wherein the thickness of the card has been enlarged for illustration purposes;

FIG. 4 is a top view of a large sheet containing a plurality of credit cards to be die cut from the sheet;

FIG. 5 is a schematic view of an arrangement for overlaying a transparent plastic film on the metal containing layer of the sheet of FIG. 4; and

FIG. 6 is a block diagram flow chart illustrating the sequence of steps in the method of the invention for making the credit card of FIG. 1.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, FIGS. 1–3 illustrate a credit card 1 according to the present invention. As shown in the cross-sectional view of FIG. 3 wherein the thickness of the card 1 has been enlarged for illustration purposes, the credit card 1 comprises a plastic substrate 2, a metal containing layer 3 overlayed on the front surface of the substrate 2, and a transparent film 4 over on the metal containing layer 3. The metal containing layer 3 extends over the entire front side surface of the plastic substrate 2 as depicted in FIG. 1. The metal containing layer 3 is preferably a reflective, smooth, continuous layer which has printed information provided thereon. The transparent film 4 is preferably an ultraviolet curable varnish which is coated on the layer 3 having printed graphics thereon and cured (hardened) by exposing the varnish to ultraviolet light, so as to form a clear, protective film over the metal containing layer to prevent it and the printed graphics from being scratched or otherwise damaged. Upon curing the varnish film 4 is bonded to the layer 3. Thus, the front surface of the card is a scratch resistant metallic surface of gold, silver, red, green, blue or other color. Alternatively, the transparent film 4 could be a clear polyester film which is adhesively bonded to the metal containing layer 3 with a clear polyethylene adhesive as explained more fully hereinafter.

The back of the card 1 seen in FIG. 2 comprises identifying information means 5 in the form of a magnetic tape which is attached to the surface of the back side of the plastic substrate 2. The back side of the substrate as shown in FIG. 2 also has printed information thereon formed by a conventional offset lithography process, for example. An overlaminate or layer 6 of clear vinyl such as clear PVC is bonded to the back side of the plastic substrate 2 over the printed information to protect the back side of the card. The magnetic tape 5 is applied with a known process onto the outer surface of the layer 6.



The method of making the credit card 1 with a scratch resistant metallic surface on the front side thereof as shown in FIGS. 1–3 according to the present invention comprises the steps of providing the plastic substrate 2, providing the metal containing layer 3 on the front surface of the plastic substrate, printing graphics on the metal containing layer and providing the metal containing layer with the transparent film 4 to protect the metal containing layer and printed graphics thereon without breaking the layer or graphics. The credit card 1 in the disclosed embodiment is shown in actual size in FIGS. 1 and 2. The card 1 has a thickness of about 0.030 inch. The plastic substrate 2 of the card is a white vinyl material, preferably PVC, with a thickness of 0.0265 inch. The plastic substrate 2 of the card is initially part of a larger plastic substrate 7 in the form of a large sheet of the same material and thickness as the substrate 2 and depicted in FIG. 4. A plurality of individual credit cards are die cut to card size from the sheet 7 after the layer 3, the transparent film 4 and the overlaminate 6 are applied to the sheet 7.

The back of the substrate of the large sheet 7 and correspondingly the back of the plurality of cards contained therein are printed using a conventional offset lithography process. The back of the large sheet 7 and the plurality of cards 1 contained therein are then overlaminated with a clear vinyl, preferably clear PVC. A heat-activated adhesive would be applied to the overlaminate 6 at least where the graphics are subject to bleeding off the card. Bonding is accomplished in a laminating press under the application of heat and pressure, at 265° platen temperature and with a pressure of 1,000 psi, for example. The press plates which contact the front side of the plastic substrate 2 in the form of the sheet 7, and the overlaminate 6 are smooth so that they not only bond the overlaminate 6 to the back side of the plastic substrate 2 but also press polish the front surface of the plastic substrate 2 for receiving the metal containing layer. The thickness of the overlaminate is on the order of 0.001 inch.

The next step in the method of the invention involves heat transferring a metallized foil to the front surface of the plastic substrate 2 to form the metal containing layer 3 thereon. The metallized foil 3 can for example, be an aluminum or aluminum alloy which has been vapor deposited in a vacuum onto a thin, 0.00075 inch thick, polyester film as a carrier, the polyester film having been first coated with a release agent. The aluminum or aluminum alloy vapor is deposited on the coated carrier at high temperature in the form of a very thin film or foil with a thickness of less than 0.001 inch, for example. A dry heat-activated adhesive material is then applied over the metallized foil on the carrier. The total thickness of the carrier with release agent, metallized foil and adhesive is only on the order of 0.001 inch. The aluminum metal can be treated to have a gold, silver, red, green, blue or other colored, metallized surface. This heat transfer metallized foil is a known, commercially available product. The metallized foil 3 is, according to the method of the invention, heat transferred to the press polished front surface of the plastic substrate 2 under the application of heat and pressure using a hydraulic laminating press of the type used in overlaminating the back of the plastic substrate with clear vinyl. A platen temperature of 265° F. and a hydraulic pressure of 1,000 psi can be used, for example, during the transfer. Alternatively, a hot silicone roller applicator could be employed for heat transferring the metallized foil 3

to the press polished front surface of the plastic substrate 2. The heat and pressure activate the adhesive on the outer surface of the foil 3 and react with the release agent between the thin polyester carrier film and the metal foil to permit removal of the carrier film from the foil after the metal foil has been adhesively bonded to the front surface of the substrate 2 by means of the heat-activated adhesive applied thereto.

The outer surface of the metallic foil 3 which is bonded to the substrate 2 is then printed as desired using a silk-screen printing technique with ultraviolet curable ink. The printed graphics can be written information, pictorial illustrations or other indicia. Ultraviolet light is directed to the ink immediately after printing to polymerize, i.e., cure the ink in order to hold the detail of fine lines and other graphics which have been printed. During the printing operation it is necessary to eliminate the static electricity which tends to occur with the processing of metal-plastic laminates. This is accomplished by directing ionized air against the laminated sheets as they are fed through the silk-screen printing apparatus. Also, grounded, conductive tinsel is draped in the vicinity of the moving laminated sheets in order to eliminate the static electricity associated therewith. A sheet feed type process is employed wherein the individual sheets are floated on air rather than being slid over one another as in a stream fed type process thereby reducing the generation of static electricity.

The printed, metallized foil 3 is next provided with an overlaminate of a transparent film 4. Preferably, the transparent film is formed by coating the foil 3 with an ultraviolet curable varnish. One method of applying this coating is to silk-screen the varnish on the metallized foil 3 of the large sheet containing a plurality of the substrates 2 and then pass the sheet under one or more ultraviolet lamps which cure (harden) the varnish so that it is bonded to the foil 3. Other commercial coating or printing processes equipped with ultraviolet lamps could also be used to apply the varnish and cure it. Alternatively, the film 4 can be a clear polyester film which is coated on one surface with a clear, heat-activated, water based adhesive such as polyethylene adhesive. The thickness of the varnish, or polyester film with adhesive, need only be 0.0013 inch, for example. A roll of the adhesive coated polyester film 8 is shown in FIG. 5. The film is drawn from the roll 8 and passed over a shoe 9 which is heated to a temperature of 250°–265° F., for example, in order to activate the adhesive on the one side of the polyester film. The heated polyester film and the plastic substrate 2 in the form of large sheet 7 are then conveyed between opposed nip rollers 10 and 11 to press the polyester film against the metal foil 3 on the substrate 2 to bond the clear polyester film to the metallic foil of the plastic substrate. The metallic foil 3 underlying the clear polyester film is not broken or otherwise disfigured during either this overlaminating or during the application and curing of the varnish. The individual cards 1 are then die cut from the sheet 7. Following this, the magnetic tapes 5 are applied to the back surface of the cards in a conventional manner.

While I have shown and described only one embodiment in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible to numerous changes and modifications as known to those skilled in the art. For example, the specific thicknesses and materials of the disclosed preferred embodiment of the credit card are exemplary and not limiting. The identifying information means on the card could also have a form other than the magnetic tape disclosed herein such as embossed indicia provided in the card. Therefore, I do not wish to be limited to the details shown and described herein, but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

I claim:

1. A credit card comprising a plastic substrate in the form of a card, a metal containing layer in the form of a metallic foil overlayed on at least substantially all of a first surface of said plastic substrate and having printed ink graphics thereon formed of an ultraviolet curable ink, and a transparent film located on said metallic foil.

2. A credit card according to claim 1, further comprising identifying information means located on said card.

3. A credit card according to claim 2, wherein said identifying information means is a magnetic tape which is attached to said card on a second surface of said plastic substrate opposite said first surface of said substrate.

4. A credit card according to claim 1, wherein said metal containing layer is bonded to said first surface of said substrate.

5. A credit card according to claim 1, wherein said metal containing layer covers the entire first surface of said substrate.

6. A credit card according to claim 1, wherein said transparent film is bonded to said metal containing layer.

7. A credit card according to claim 6, wherein said transparent film is formed of an ultraviolet curable varnish.

8. A credit card according to claim 6, wherein said transparent film is a polyester film.

9. A credit card according to claim 1, wherein said card comprises a transparent plastic film overlayed on a second surface of said substrate opposite said first surface.

10. A credit card according to claim 1, wherein said metal containing layer is a reflective, smooth, continuous layer which has printed ink graphics provided thereon.

11. A method of making a credit card with a scratch resistant metallic surface comprising the steps of providing a plastic substrate, applying a metal containing layer in the form of a metallic foil to at least substantially all of a first surface of said plastic substrate, printing ink graphics with an ultraviolet curable ink on said metal containing layer, curing the ink graphics by applying ultraviolet light thereto and providing said printed metal containing layer with a transparent film over it to protect said metal containing layer without breaking said layer.

12. A method according to claim 11, wherein said metal containing layer is bonded to said first surface of said plastic substrate during said applying step.

13. A method according to claim 12, wherein said foil is initially adhered to a carrier film via a release agent, the surface of said foil to be bonded to said first surface of said plastic substrate being coated with a heat-activated adhesive, and wherein said foil is bonded to said first surface of said plastic substrate under the application of heat and pressure to adhesively bond said foil to the first surface of said plastic substrate and release the foil from said carrier film.

14. A method according to claim 11, wherein said metal containing layer covers all of said first surface of said credit card.

15. A method according to claim 12, wherein said graphics are silk-screen printed on said metal containing layer.

16. A method according to claim 12, including eliminating static electricity from said layer and plastic substrate during said printing.

17. A method according to claim 11, wherein said transparent film is an ultraviolet curable varnish which is applied to said metal containing layer having printed graphics thereon and is cured by application of ultraviolet light.

18. A method according to claim 11, wherein said transparent film is a clear polyester film which is coated with a heat-activated adhesive on one surface thereof for bonding to said metal containing layer.

19. A method according to claim 18, wherein said heat-activated adhesive is heated and said clear polyester film is bonded to said metal containing layer of said plastic substrate by conveying said substrate and film between opposed nip rollers to press said film against said layer.

20. A method according to claim 11, further comprising the step of printing a second surface of said plastic substrate opposite said first surface and applying a layer of clear vinyl over said printed second surface prior to applying said metal containing layer to said first surface of said plastic substrate.

21. A method according to claim 11, wherein said plastic substrate is in the form of a large sheet containing a plurality of credit cards, individual credit cards being die cut to card size from said sheet after said step of providing the metal containing layer with a transparent film.

22. A method according to claim 21, wherein a magnetic tape is applied to a second surface of each card which is opposite said first surface after the credit cards are die cut from said large sheet.

23. A method according to claim 11, including press polishing said first surface of said substrate before providing said metal containing layer thereon.

24. A credit card made by the method of claim 11.

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## (54) Process for the preparation of decorative sheet.

(57) A process is provided for the preparation of a decorative sheet which comprises a first substrate sheet 11 formed of a transparent plastic material, in one or both of the surfaces of which all or a part of a pattern-printed layer 2 is embedded, a laminated sheet formed by laminating a second substrate sheet 12 formed of a transparent plastic material on one surface of the above-mentioned sheet, or a laminated sheet formed by laminating a third substrate sheet 13 formed of a plastic material having a hiding power on the above-mentioned sheet or laminated sheet. This decorative sheet has an excellent three-dimensional effect.

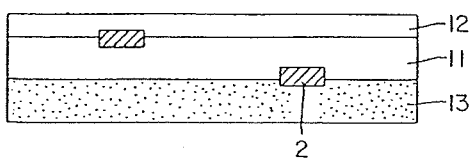


FIG. 4

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## TECHNICAL FIELD

The present invention relates to a decorative sheet having a three-dimensional effect, and a process for the preparation thereof.

## BACKGROUND ART

A decorative sheet most popularly used for the production of furniture and construction materials is a laminate of a pattern-printed plastic sheet and a transparent plastic sheet. This decorative sheet is poor in three-dimensional effect and is inevitably cheap in appearance.

As decorative sheets having a three-dimensional effect, there are known a sheet formed by pressing resin chips and a sheet obtained by extruding a resin through many nozzles, solidifying the extrudate and slicing the solid. However, these decorative sheets are defective in that the designs that can be manifested are restricted and mass production of sheets having the same design is difficult.

## DISCLOSURE OF THE INVENTION

It is an object of the present invention to provide a decorative sheet having a three-dimensional beautiful design and a process for the preparation thereof.

Typical fundamental embodiments of the decorative sheet of the present invention are shown in Figs. 1 through 4. Namely, the decorative sheet of the present invention includes a sheet comprising a transparent plastic first substrate sheet 11 and a pattern-printed layer 2 partially or wholly embedded in one or both of the surfaces of the first substrate sheet 11 (Fig. 1), a laminate sheet formed by laminating a transparent plastic second substrate sheet on one surface of the above-mentioned sheet (Fig. 2), and a sheet formed by laminating a plastic third substrate sheet 13 having a hiding power on one surface of the above-mentioned sheet or laminate sheet (Fig. 3 or 4).

## BRIEF DESCRIPTION OF DRAWINGS

Figs. 1 through 4 are sectional diagrams illustrating basic embodiments of the decorative sheet of the present invention.

Figs. 5 through 7 are sectional views illustrating preferred embodiments of the decorative sheets of the present invention.

Figs. 8 through 12 illustrate the preparation process of the present invention, which are sectional views, similar to Figs. 1 through 4, showing semi-manufactured products after the respective steps.

## BEST MODE FOR CARRYING OUT THE INVENTION

Typical basic embodiments of the decorative sheet of the present invention are shown in Figs. 1 through 4. Namely, the decorative sheet of the present invention includes a sheet comprising a transparent plastic first substrate sheet 11 and a pattern-printed layer 2 partially or wholly embedded in one or both of the surfaces of the first substrate sheet 11 (Fig. 1), a laminate sheet formed by laminating a transparent plastic second substrate sheet on one surface of the above-mentioned sheet (Fig. 2), and a sheet formed by laminating a plastic third substrate sheet 13 having a hiding power on one surface of the above-mentioned sheet or laminate sheet (Fig. 3 or 4).

In the present invention, by laminating the second substrate sheet or the third substrate sheet on the surface, in which the pattern-printed layer of the first substrate sheet is partially embedded, a part of the pattern-printed layer is embedded in not only the first substrate layer but also the second or third substrate sheet.

As pointed out hereinbefore, a transparent plastic sheet can be used as the first and second substrate sheets. The term "transparent" used for the plastic sheet is meant not only "colorless transparent" but also "colored transparent", and so-called "delustered transparent" sheet which is formed by adding a delustering agent to deluster the surface. Furthermore, a glittering pigment described hereinafter can be incorporated into the plastic material, so far as the transparency is not degraded.

Sheets of the same kind can be used for the first and second substrate sheets, or sheets differing in the material or color can be used for the first and second substrate sheets.

The hiding power can be imparted to the third substrate sheet by kneading a pigment having a hiding power into a sheet-forming material and making a sheet from the kneaded material, or by printing the

substrate sheet. Titanium dioxide and carbon black can be mentioned as typical examples of pigments having a hiding power, and an appropriate pigment is used according to the desired color of the product sheet. Glittering pigments such as titanium-coated mica, natural pearl foil, inorganic lead type artificial pearl, metal powder and a crushed piece of a metal-vacuum-deposited plastic film can be used.

As typical instances of the plastic material used for the first, second and third substrate sheets, there can be mentioned cellulose resins such as cellophane and an acetate resin, polyolefin resins such as polyethylene, polypropylene and polymethylpentene, polyester resins such as polyethylene terephthalate and polybutylene terephthalate, vinyl polymers such as polyvinyl chloride, polyvinylidene chloride and a vinyl chloride/vinyl acetate copolymer, styrene resins such as polystyrene and an AS resin, polycarbonate, polyvinyl alcohol, polyamides such as nylon 6 and nylon 66, polyacrylate, polyimide and polyether ether ketone. In view of the workability, flame retardance and cost polyvinyl chloride is preferably used.

In view of the strength and the easiness of post working after the preparation, it is preferred that the thickness of each substrate sheet be 0.05 to 1.0 mm. In view of the easiness of embedment of the pattern-printed layer, it is preferred that the first through third substrate sheets be composed of a thermoplastic resin as mentioned above. If such physical properties as surface strength and chemical resistance are required for the substrate sheets, a thermosetting resin or an ionizing radiation-curable resin can be used. Thermosetting or ionizing radiation-curable sheets are used as the first through third substrate sheets in which a pattern-printed layer is to be embedded, the pattern is embedded in the state where the substrate sheets have a higher hardness and a lower compressibility than those of the pattern ink layer, and the sheets are cured by heat or an ionizing radiation. In this case, different curing means are adopted for curing the ink and the sheets, respectively, so that the substrate sheets are not cured by the curing means for the ink. For example, the ink is cured by an ionizing radiation and the substrate sheets are cured by heat. A sheet of a polyurethane, an epoxy resin, a melamine resin or an unsaturated polyester resin is preferably used as the heat-curable sheet.

As the ionizing radiation-curable sheet, there can be used an ultraviolet ray-curable resin comprising 100 parts by weight of a thermoplastic resin such as polyvinyl chloride, an acrylic resin or a thermoplastic resin and the following components incorporated therein:

(a) 10 to 50 parts by weight of a curable resin such as an unsaturated polyester resin, a spiran resin, a urethane resin, an acrylic resin, an epoxy resin, an epoxy acrylate resin or a diallyl phthalate resin or a highly functional polymer constituting such a curable resin;

(b) up to 30 parts by weight of a plasticizer, for example, an acrylic acid ester such as allyl acrylate or allyl methacrylate, or a phthalic acid ester such as dioctyl phthaltate or dibutyl phthalate, according to need;

(c) a small amount of a reaction initiator such as benzoyl peroxide or azonisisobutyronitrile according to need;

(d) 0.5 to 5 parts by weight of a photosensitizer such as a benzoiin alkyl ether or benzophenone; and

(e) a small amount of a catalyst such as a tertiary amine or an organic metal compound or a stabilizer such as a metal salt of stearic acid.

As the ionizing radiation-curable resin, there can be used the following resins (1) and (2).

(1) Polymers having a glass transition temperature of 0 to 250 °C, which have a radical polymerizable unsaturated group.

More specifically, there can be mentioned polymers formed by homopolymerizing or copolymerizing the following compounds (i) through (viii), into which a radical-polymerizable unsaturated group is introduced by any of methods (a) through (d) described below.

(i) A hydroxyl group-containing monomer such as N-methylol (meth)acrylamide, 2-hydroxyethyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate or 2-hydroxy-3-phenoxypropyl (meth)acrylate.

(ii) A carboxyl group-containing monomer such as (meth)acrylic acid or (meth)acryloyloxyethyl monosuccinate.

(iii) An epoxy group-containing monomer such as glycidyl (meth)acrylate.

(iv) An aziridinyl group-containing monomer such as 2-aziridinylethyl (meth)acrylate and allyl 2-aziridinylpropionate.

(v) An amino group-containing monomer such as (meth)acrylamide, diacetone (meth)acrylamide, dimethylaminoethyl (meth)acrylate or diethylaminoethyl (meth)acrylate.

(vi) A sulfone group-containing monomer such as 2-(meth)acrylamido-2-methylpropane-sulfonic acid.

(vii) An isocyanate group-containing monomer, for example, an adduct of a diisocyanate and a radical-polymerizable monomer having an active hydrogen atom, such as a 1 mole/l mole adduct of 2, 4-toluene diisocyanate and 2-hydroxyethyl (meth)acrylate.

(viii) A product obtained by copolymerizing a compound as mentioned above with a copolymerizable monomer as mentioned below for adjusting the glass transition point of the above-mentioned copolymer or adjusting the physical properties of the cured film.

As the copolymerizable monomer, there can be mentioned, for example, methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, butyl (meth)acrylate, isobutyl (meth)acrylate, t-butyl (meth)acrylate, isoamyl (meth)acrylate, cyclohexyl (meth)acrylate and 2-ethylhexyl (meth)acrylate.

An ultraviolet ray- or electron beam-curable resin can be obtained by introducing a radical-polymerizable unsaturated group by reacting a polymer as mentioned above according to any of methods (a) through (d) described below.

(a) A homopolymer or copolymer of a hydroxyl group-containing monomer is condensed with a hydroxyl group-containing monomer as mentioned above.

(b) A homopolymer or copolymer of a monomer containing a carboxyl group or sulfone group is condensed with a hydroxyl group-containing monomer as mentioned above.

(c) A homopolymer or copolymer of a monomer containing an epoxy group, isocyanate group or aziridinyl group is subjected to addition reaction with a hydroxyl group- or carboxyl group-containing monomer as mentioned above.

(d) A homopolymer or copolymer of a monomer containing a hydroxyl group or carboxyl group is subjected to addition reaction with a monomer containing an epoxy group or aziridinyl group or a 1 mole/1 mole adduct of an isocyanate compound and a hydroxyl group-containing acrylic acid ester monomer.

(2) Compounds having a melting point of room temperature (20 °C) to 250 °C and a radical-polymerizable unsaturated group.

As specific examples, there can be mentioned stearyl (meth)acrylate, triacryl isocyanurate, cyclohexanediol di(meth)acrylate and spiroglycol di(meth)acrylate.

A mixture of the compounds (1) and (2) can be used, and a radical-polymerizable unsaturated monomer can be added to the compounds (1) and (2). This monomer exerts functions of improving the crosslinking density by irradiation with an ionizing radiation and improving the heat resistance. In addition to the above-mentioned monomers, there can be used ethylene glycol di(meth)acrylate, polyethylene glycol di(meth)-acrylate, hexanediol di(meth)acrylate, trimethylolpropane di- or tri-(meth)acrylate, pentaerythritol tri-or tetra-(meth)acrylate, dipentaerythritol hexa(meth)acrylate, (poly)ethylene glycol diglycidyl ether di(meth)acrylate, (poly)propylene glycol diglycidyl ether di(meth)acrylate and sorbitol tetraglycidyl ether tetra(meth)acrylate. The monomer is preferably used in an amount of 0.1 to 100 parts by weight per 100 parts by weight of the solid of the monomer/copolymer mixture.

The foregoing composition can be cured with electron beams, and in the case where the curing is effected with ultraviolet rays, a compound capable of generating a radical under irradiation with ultraviolet rays, for example, benzoquinone, benzoin, a benzoin ether such as benzoin methyl ether, a acetophenone halide or biacetyl, is preferably added.

Each of these ionizing radiation-curable resins can be formed into a sheet by the known calender method or casting method.

An appropriate ink is used for the pattern-printed layer according to the sheet used. For example, there can be used a delustered transparent or colored transparent ink and a glittering pigment-containing ink. A glittering pigment as mentioned above can be used.

If the third substrate sheet to which a hiding power is given by using a glittering pigment is used in combination with a pattern-printed layer having a glitter different from that of the third substrate sheet, a decorative sheet having an enhanced three-dimensional effect is obtained.

In the embodiment where the first or second substrate sheet is disposed between the pattern-printed layer and the third substrate sheet as shown in Fig. 3, if the pattern-printed layer is formed by using an ink having a hiding power, for example, an ink comprising titanium oxide or carbon black, a shade is formed on the third substrate sheet and a decorative sheet having a deep appearance can be obtained.

Transparent inks having the same color can be used for the pattern-printed layer and the first or second substrate sheet. If the refractive index of the substrate sheet is different from that of the pattern-printed layer, a three-dimensional effect can be manifested.

In order to attain a sufficient effect by embedding, the thickness of the pattern-printed layer is preferably selected within the range of 20 to 150 $\mu$, especially 50 to 100 $\mu$m.

In order to prevent collapsing or sagging of the printed layer upon the preparation of the decorative sheet, it is preferred that the compressibility of the pattern-printed layer be lower than that of each substrate sheet. An ink used for this pattern-printed layer is one comprising as a vehicle a curable or thermoplastic resin having a high glass transition point or comprising a non-compressible filler incorporated therein.

As the curable resin, there can be mentioned a polysiloxane resin, an ionizing radiation-curable resin and a two-pack type curable resin such as a urethane, epoxy, melamine or unsaturated polyester resin.

As the non-compressible filler, there can be mentioned pulverization products of curable resins such as a phenolic resin, a urea-melamine resin, a polyester resin, a polyurethane resin and an epoxy resin, and known fillers such as aluminum hydroxide, magnesium carbonate, potassium sulfate, barium sulfate, calcium carbonate, alumina, stone powder, FRR waste, siliceous sand, glass fiber, clay, kaolin and talc.

The typical processes for the preparation of decorative sheets of the above-mentioned basic embodiments will now be described.

The process of the present invention for the preparation of a decorative sheet as shown in Fig. 1 comprises the following steps:

1) performing buildup printing of one or both of surfaces of a first substrate sheet formed of a transparent plastic material with an ink comprising a curable resin as the vehicle to form a pattern-printed layer;

2) curing the pattern-printed layer; and

3) heat-compressing the first substrate sheet to embed the pattern-printed layer in the first substrate sheet.

The process of the present invention for the preparation of a decorative sheet as shown in Fig. 2, 3 or 4 comprises the following steps:

1) performing buildup printing of one or both of surfaces of a first substrate sheet formed of a transparent plastic material with an ink comprising a curable resin as the vehicle to form a pattern-printed layer;

2) curing the pattern-printed layer; and

3A) piling a second substrate sheet formed of a transparent plastic material and/or a third substrate sheet formed of a plastic material having a hiding power on the first substrate sheet and heat-compressing the assembly to laminate the substrate sheets so that the pattern-printed layer is embedded in one or two or more of the substrate sheets.

A decorative sheet as shown in Fig. 3 can also be prepared by adopting, instead of the above-mentioned process, the preparation process comprising the following steps:

1B) performing buildup printing of one surface of a third substrate sheet with an ink comprising a curable resin as the vehicle to form a pattern-printed layer;

2) curing the pattern-printed layer; and

3B) piling a first substrate sheet on the printed surface of the third substrate sheet and heat-compressing the assembly to embed the pattern-printed layer in the first substrate sheet and/or the third substrate sheet.

In each of the above-mentioned preparation processes, if both the substrate sheets having the pattern-printed layer interposed therebetween have the same hardness when the respective substrate sheets are laminated with the pattern-printed layer interposed therebetween, there can be obtained a decorative sheet in which the printed layer is located at the middle position between both the substrate sheets, as shown in Fig. 2. If both the substrate sheets having the printed layer interposed therebetween are different in the hardness, there can be obtained a decorative sheet in which the printed layer is biased toward the softer substrate sheet, as shown in Fig. 4.

Formation of the pattern can be accomplished by the known method capable of performing buildup printing, such as gravure printing, offset gravure printing, silk screen printing, offset printing, electrostatic printing or jet printing.

Gravure printing is preferably adopted because a beautiful pattern can be formed even if the surface of a sheet to be printed is rough to a certain degree. A pattern of a fretwork or polka dots, an abstract pattern or a natural pattern such as a rift pattern or a grain pattern can be arbitrarily selected as the pattern, and various letters or symbols can be added, if desired.

In each of the foregoing processes, a curable resin as mentioned above can be used as the ink vehicle.

Needless to say, an appropriate curing means is selected according to the kind of the resin used at the step of curing the pattern-printed layer. For example, when an ionizing radiation-curable resin is used, curing is effected by irradiation with an ionizing radiation.

In each of the foregoing processes, the pattern-printed layer is formed by an ink comprising a curable resin as the vehicle. However, of course, an ink comprising a resin having a high glass transition point as the vehicle or an ink comprising a non-compressible fill incorporated therein can be used. In this case, the step of curing the printed layer is not necessary.

Lamination of the respective sheets conducted simultaneously with embedment of the pattern-printed layer is accomplished only by the application of pressure. However, it is preferred that the adhesiveness between the pattern-printed layer and the substrate sheet or between the substrate sheets be increased. In the case where embossing is carried out simultaneous with the lamination, in view of the embossing

adaptability and the pattern-printed layer-embedding effect, it is preferred that the lamination be effected by applying heat and pressure simultaneously to the respective substrate sheets. More specifically, the lamination is effected by using a press comprising a mirror surface plate or by a doubling operation utilizing heat and pressure. According to a preferred embodiment, in the decorative sheet of the present invention, an embossed pattern 3 is formed on the surface of the decorative sheet and/or between the substrate sheets, as shown in Fig. 5.

The embossed pattern 3 can be formed on the entire surface including the pattern-printed layer or on the portion of the surface excluding the pattern-printed layer.

The kind of the embossed pattern is not particularly critical but an optional pattern can be adopted. For example, there can be adopted an aggregate of patterns comprising groups of parallel straight lines or curves and a closed boundary line enclosing these lines or curves. It is preferred that the difference of the direction of the parallel straight lines or curves between two groups adjacent to each other through the boundary line be at least 5° and the depth and interval of the lines be 0.1 to 10 μm. The design of this pattern type is characterized in that the gloss of each closed region is changed according to the visual angle. Because all of the directions of respective adjacent line groups having boundary line in common are different from one another, it is necessary according to the "theorem of four-colour problem" of the phase geometry that there should be present at least 4 kinds of dirrection differences.

A decorative sheet having an embossed pattern between sheets is prepared, for example, through the following steps:

1C) performing buildup printing on one surface of a second substrate sheet or third substrate sheet with an ink comprising a curable resin as the vehicle to form a pattern-printed layer;

2C) curing the pattern-printed layer and heat-compressing the substrate sheet by using an embossing plate to embed the pattern-printed layer in the second or third substrate sheet and form an embossed pattern on the printed surface; and

3C) piling a first substrate sheet on the printed surface of the second or third substrate sheet and heat-compressing the assembly to effect lamination.

At the laminating step [step 3A), 3B) or 3C)] of each of the above-mentioned preparation processes, if the lamination of the substrate sheets by heat compression is carried out by using an embossing plate, a decorative sheet having an embossed surface can be obtained.

Of the above-mentioned decorative sheets of the present invention, in the embodiment where a pattern-printed layer is formed between substrate sheets, it is preferred that a primer layer 4 be disposed between the sheets to tighly bond the respective layers to each other, as shown in Fig. 6. This embodiment is especially recommended when a pattern is printed with no good bondability to the substrate sheets (thermoplastic sheets are mainly used as pointed out hereinbefore) constituting the decprative sheet.

The requirement that the preparation should be easy and cause no deformation of the pattern-printed layer, the pattern-printed layer should be sufficiently embedded in respective substrate sheets to produce a beautiful design and the respecyive layers should be tightly bonded to one another is satisfied by the following decorative sheet. Namely, the above requirement is satisfied by a decorative sheet in which a pattern-printed layer formed by an ink comprising an ionizing radiation-curable resin or its mixture with an ionizing radiation-uncurable resin as the vehicle and a primer layer is formed by an ionizing radiation-uncurable resin or its mixture with an ionizing radiation-curable resin.

The process of the present invention for the preparation of this decorative sheet comprises the following steps:

1D) performing buildup printing of one or both of surfaces of a first substrate sheet with an ink comprising an ionizing radiation-curable resin or its mixture with an ionizing radiation-uncurable resin as the vehicle to form a pattern-printed layer;

2-1) semi-curing the pattern-printed layer by irradiation with an ionizing radiation;

2-2) coating an ionizing radiation-uncurable resin or its mixture with an ionizing radiation-curable resin on the semi-cured pattern-printed layer to form a primer layer;

2-3) irradiating the assembly with an ionizing radiation again to completely cure the pattern-printed layer; and

3D) piling a second substrate sheet and/or a third substrate sheet on the first substrate sheet and heat-compressing the assembly to embed pattern-printed layer in one or two or more of the substrate sheets.

As is seen from Figs. 8 through 12 showing intermediate products after respective steps, another preparation process of the present invention comprises the following steps:

1E) performing buildup printing of one surface of a third substrate sheet 13 with an ink comprising an ionizing radiation-curable resin or its mixture with an ionizing radiation-uncurable resin as the vehicle to form a pattern-printed layer 2 (Fig. 8);

2-1) semi-curing the pattern-printed layer 2 by irradiation with an ionizing radiation (Fig. 9);

2-2) coating an ionizing radiation-uncurable resin or its mixture with an ionizing radiation-curable resin on the semi-cured pattern-printed layer 2 to form a primer layer 4 (Fig. 10);

2-3) irradiating the assembly with an ionizing radiation again to completely cure the pattern-printed layer 2 (Fig. 11); and

3E) piling a first substrate sheet 11 on the printed surface of the third substrate sheet 13 (Fig. 12) and heat-compressing the assembly to effect lamination so that the pattern-printed layer 2 is embedded.

A decorative sheet prepared according to this process is shown in Fig. 6.

In the foregoing processes, an ionizing radiation-curable resin or its mixture with an ionizing radiation-uncurable resin is used as the ink vehicle. When a mixture containing the uncurable resin in a larger amount is used as the vehicle, it becomes difficult to embed the pattern-printed layer in the respective substrate sheets while maintaining the three-dimensional shape in the pattern-printed later, and therefore, it is preferred that the amount of the uncurable resin be adjusted to up to 70% by weight.

As the ionizing radiation-curable resin, there can be used a composition comprising an oligomer of epoxy acrylate, urethane acrylate, and acrylic acid-modified alkyd or an acrylic acid-modified polyester and a monomer such as neopentyl glycol diacrylate, pentaerythritol triacrylate, trimethylolpropane triacrylate or trimethylolpropane trimethacrylate incorporated for adjusting the crosslinked structure or the viscosity. This resin can be sufficiently cured by irradiation with electron beams. In the case where curing is effected by irradiation with ultraviolet rays, a photo-polymerization initiator of the benzoin, acetophenone, benzylketal or ketone/amine type is generally added.

As typical instances of the ionizing radiation, there can be mentioned electron beams and ultraviolet rays.

Electron beams can be generated from various electron beam accelerators, and electron beams having an energy of 50 to 1000 KeV, preferably 100 to 300 KeV, are used. Ultraviolet rays generated from a high-pressure mercury lamp or other ultraviolet ray source are used.

As examples of the resin not cured under irradiation with an ionizing radiation, there can be mentioned cellulose derivatives such as ethyl cellulose, ethylhydoxyethyl cellulose, cellulose acetate propionate and acetyl cellulose, styrene resin such as polystyrene and poly-α-methylstyrene, (meth)acrylic acid resins such as polymethy (meth)acrylate, polyethyl (meth)acrylate and polybutyl (meth)acrylate, rosin ester resins such as rosin, rosin-modified maleic acid resins, rosin-modified phenolic resins and polymerized rosin, and polyvinyl acetate, coumarone resins, vinyltoluene resins, polyvinyl chloride, vinyl chloride/vinyl acetate copolymers, polyesters, polyurethanes and butyral resins. Mixtures of two or more of these resins can also be used.

The primer is selected from ionizing radiation-uncurable resins in view of the respective substrate sheets and the vehicle of the printing ink. For example, in the case where each of the two substrate sheets having the pattern printed layer interposed therebetween is a sheet of polyvinyl chloride and the vehicle of the printing ink is a resin mixture containing polyvinyl chloride, the primer is preferably composed of polyvinyl chloride or a resin mixture comprising polyvinyl chloride as the main component.

A mixture comprising a resin curable under irradiation with an ionizing radiation and a resin not cured under irradiation with an ionizing radiation can be used as the primer, but if the amount of the curable resin is large, the adhesive force between the decorative sheet layers if weakened, and therefore, the amount of the curable resin is reduced.

A protecting layer 6 or a backing layer 7 can be optionally formed according to the intended use, as shown in Fig. 7, or a sticking agent and a release paper can be laminated.

The protecting layer is preferably formed of a colorless transparent or colored transparent resin excellent in the surface properties such as weatherability, abrasion resistance and stain resistance. For example, an ionizing radiation-curable resin, a two-liquid curing type resin, a fluorine resin and a polysiloxane resin are preferably used.

The backing material is used for facilitating the working, reducing the elongation or contraction of the decorative sheet and imparting a desired thickness to the decorative sheet.

The kind of the backing material is not particularly critical, but a composition formed by incorporating a filler such as calcium carbonate into polyvinyl chloride (an inexpensive reclaimed product can be used) or bitumen is preferably used in view of the dimensional stability and heat resistance. If an especially high dimensional safety is required, a composition formed by incorporating a glass fiber can be used. A nonwoven fabric, a glass cloth or other woven fabric can be laminated directly or through the above-mentioned layer. A metal sheet such as an iron sheet or an aluminum sheet or a wood substrate such as a plywood or a particle board can be used as the backing material.

The laminate of the sticking agent and release paper facilitates the working of the decorative sheet in situ.

Known sticking agents and release papers can be use, for example, a sticking agent such as an ethylene/vinyl acetate copolymer or a polyurethane and a silicone release paper can be used.

For the production of a decorative sheet having a protecting layer or a backing material, the protecting layer or sticking material can be formed on a completed decorative sheet, or can be formed at an optional step during the preparation.

The decorative sheet of the present invention is generally used as a surface decorative material for a wall surface or floor in the state bonded to a substrate. Furthermore, there can be adopted a simultaneous injection molding and bonding method, and the decorative sheet is preliminarily molded on a metal mold as required and a resin is cast into the mold to effect integration, whereby a product having a decorative sheet laminated on the surface of a three-dimensional molded article can be obtained.

In the decorative sheet of the present invention, a three-dimensional effect can be manifested by embedding the pattern-printed layer in the substrate sheets. This effect is enhanced by combining the respective substrate sheets and pattern-printed layer appropriately. For example, if the brightness or gloss of the pattern-printed portion is higher than that of the substrate sheet, the pattern is seen is rising. In the reverse case, the pattern is seen as sinking. In the former case, if a transparent substrate sheet (first or second substrate sheet) is made present as an intermediate layer, the effect is enhanced. If this embedding of the pattern-printed layer is combined with printing of a picture pattern or embossing, a more complicated three-dimensional effect can be attained.

According to the preparation process of the present invention, the above-mentioned decorative sheet can be easily obtained, and furthermore, since the pattern-printed layer is formed by an ink comprising a curable resin as the vehicle, sagging or collapsing of the pattern is not caused.

In the embodiment where a primer layer is formed between substrate sheets having the pattern-printed layer, there is no risk of occurrence of interlaminar peeling in the decorative sheet. Since the same or similar plastic materials are selected for the respective substrate sheets and primer, the adhesive force among them is sufficiently strong. The reason for the occurrence of interlaminar peeling in the decorative sheet is that the adhesive force to the pattern-printed layer is not sufficient. At the point when a pattern is printed on the substrate sheet, the pattern-printed layer is in the semi-cured state, and therefore the pattern-printed layer is tightly bonded to the printed sheet. Accordingly, it is the adhesive force between the sheet to be laminated after the curing of the pattern-printed layer and the pattern-printed layer that is important and should be taken into consideration.

According to the preparation process of the present invention, in the state where the pattern-printed layer is semi-cured, namely in the state where the curing reaction of the ionizing radiatio-curable resin, such as crosslinking or polymerization, is not completed but a part of the resin is soluble or wettable with other resin or solvent, the primer is coated. Therefore, permeation or dissolution is caused between the primer layer and the pattern-printed layer and a good bonding is attained between the two layers.

Since the pattern-printed layer is then completely cured and the lamination is effected, the pattern-printed layer can be embedded in the pattern-printed substrate sheet and/or the substrate sheet to be laminated on the pattern without deformation of the pattern. Furthermore, since the sheet to be laminated is tightly bonded to the primer layer as pointed out hereinbefore, the respective layers are tightly bonded to one another in the decorative sheet.

Example 1

An abstract pattern was gravure-printed on one surface of a colorless transparent polyvinyl chloride (PVC) sheet having a thickness of 0.3 mm ("W-500" supplied by Riken Vinyl Kogyo) as the first substrate sheet with an ultraviolet ray-curable ink ("Seika Beam P" supplied by Dainichi Seika Kogyo) by using a gravure printing plate having a printing depth of 150 μm so that a margin was left, and the pattern-printed substrate sheet was irradiated with ultraviolet rays (having an intensity of 160 W/cm) for 2 seconds to effect curing.

The so-printed sheet was piled on a gray-colored PVC sheet having a thickness of 0.1 mm and a hiding power (supplied by Riken Vinyl Kogyo) as the third substrate sheet so the printed surface of the printed sheet was located above. Then, a mirror surface plate was placed on the topmost surface, and the assembly was pressed under a force of 15 kg/cm2 for 15 minutes from below and above by pressing plates heated at 150 °C through cushions. The pressing plates were cooled to 10 to 20 °C while the application of the force was continued, and the pressing plates were then removed. Thus, the pattern-printed layer was embedded in the sheets simultaneously with lamination to obtain a decorative sheet of the present

invention.

Example 2

In the same manner as described in Example 1, a pattern-printed layer was formed and cured on the same third substrate sheet as used in Example 1. The same first substrate sheet as used in Example 1 was piled on the printed surface, and the assembly was pressed in the same manner as described in Example 1 to embed the pattern-printed layer into the sheets simultaneously with the lamination, whereby a decorative sheet of the present invention was obtained.

Example 3

An abstract pattern was gravure-printed on one surface of the same first substrate sheet as used in Example 1 with an ink comprising 100 parts by weight of a PVC type ink (V-12 supplied by Dainichi Seika Kogyo) and 60 parts by weight of calcium carbonate having an average particle size of 30 μ as the non-compressible filler by using a gravure printing plate having a printing depth of 150 μ so that a margin was left.

A composition described below was molded into a sheet having a thickness of 1.5 mm as the backing material by the calender method:

| | |
|---|---|
| Polyvinyl chloride (reclaimed product) | 100 parts by weight |
| Plasticizer (DOP) | 30 parts by weight |
| Pigment (carbon black) | 2 parts by weight |
| Heat stabilizer (AC-113 supplied by Adeca-Argus) | 2 parts by weight |

A light-yellow PVC sheet having a thickness of 0.1 mm (supplied by Riken Vinyl Kogyo) as the second substrate sheet and the pattern-printed PVC sheet were piled on the backing material so that the printed surface was located on the inner side. In the same manner as described in Example 1, the assembly was pressed to embed the pattern-printed layer into the sheets simultaneously with the lamination, whereby a decorative sheet of the present invention was obtained.

Example 4

In the same manner as described in Example 1, both of surfaces of a colorless transparent PVC sheet having a thickness of 0.3 mm (W-500 supplied by Riken Vinyl Kogyo) as the first substrate sheet were gravure-printed with a pearl pigment-incorporated ultraviolet ray-curable ink (Seika Beam supplied by Dainichi Seika Kogyo) and the ink was cured,

A pearl pigment-incorporated transparent PVC sheet having a thickness of 0.1 mm (supplied by Riken Vinyl Kogyo) as the second substrate sheet and a white PVC sheet having a thickness of 0.5 mm (supplied by Riken Vinyl Kogyo) as the third substrate sheet were piled on the printed sheet. In the same manner as described in Example 1, the assembly was pressed to embed the pattern-printed layer into the sheets simultaneously with the lamination.

A pigment-free ultraviolet ray-curable ink (Seika Beam supplied by Dainichi Seika Kogyo) was coated on the first substrate sheet by a gravure coater, and curing was carried out under the same conditions adopted for curing the pattern-printed layer to form a protecting layer having a thickness of 10 μm, whereby a decorative sheet of the present invention was obtained.

Example 5

A sheet having the same layer structure as described in Example 1 was heat-pressed in the same manner as described in Example 1 except that a hairline-shaped embossing plate was used instead of the mirror surface plate, whereby the portion where the pattern-printed layer was not present was embossed.

A vinyl chloride/vinyl acetate copolymer type sticking agent was roll-coated on the surface which had not been embossed, and a release paper was applied to the sticking agent-coated surface to obtain a decorative sheet of the present invention.

Example 6

One surface of a colorless transparent PVC sheet having a thickness of 0.3 mm (supplied by Riken Vinyl Kogyo) as the first substrate sheet was gravure-printed with a white ink formed by mixing an ultraviolet raycurable ink (EXD-1216 supplied by Dainichi Seika Kogyo) and a vinyl choloride type ink (V-12 supplied by Dainichi Seika Kogyo) at a ratio of 95/5 by using the same gravure printing plate as used in Example 1 and the printed surface was irradiated with ultraviolet rays (having an intensity of 80 W/cm) for 1 second to semi-cure the pattern-printed layer. The printed surface of this sheet was solid-printed with a vinyl chloride type ink (V-12 supplied by Dainichi Seika Kogyo) so that the dry thickness was 2 μ, and the printed surface was irradiated with ultraviolet rays (having an intensity of 80 W/cm) for 2 seconds to completely cure the pattern-printed layer.

A gray-colored PVC sheet having a thickness of 0.08 mm (supplied by Riken Vinyl Kogyo) as the third substrate sheet and the pattern-printed PVC sheet were piled on the same backing material as used in Example 3 so that the printed surface was located below. The assembly was heat-pressed in the same manner as described in Example 1 to embed the pattern-printed layer into the sheets simultaneously with the lamination.

The obtained decorative sheet was beautiful and had a thress-dimensional effect, and the respective layers were tightly bonded to one another and could not be peeled by hand.

## INDUSTRIAL APPLICABILITY

The decorative sheet of the present invention has a three-dimensional effect and a beautiful design. A cabinet or furniture prepared by using this decorative sheet has a high-grade feel. The decorative sheet of the present invention on which a backing material is fixed is especially suitable as a floor material.

If a primer layer is disposed between sheets having the pattern-printed layer in the decorative sheet of the present invention, a beautiful design in which the shape of the printed pattern is retained in a good state can be attained, and interlaminar peeling is not substantially caused and the decorative sheet has an excellent durability.

Accordingly, the decorative sheet of the present invention can be applied to furniture and floor materials for which a high durability and an excellent design or appearance are required.

## Claims

1. A process for the preparation of a decorative sheet, which comprises the following steps:
   1) performing buildup printing of one or both of surfaces of a first substrate sheet formed of a transparent plastic material with an ink comprising a curable resin as the vehicle to form a pattern-printed layer;
   2) curing the pattern-printed layer; and
   3A) piling a second substrate sheet formed of a transparent plastic material and/or a third substrate sheet formed of a plastic material having a hiding power on the first substrate sheet and heat-compressing the assembly to laminate the substrate sheets so that the pattern-printed layer is embedded in one or two or more of the substrate sheets.

2. A process for the preparation of a decorative sheet, which comprises the following steps:
   1B) performing buildup printing of one surface of a third substrate sheet with an ink comprising a curable resin as the vehicle to form a pattern-printed layer;
   2) curing the pattern-printed layer; and
   3B) piling a first substrate sheet on the printed surface of the third substrate sheet and compressing or heat-compressing the assembly to embed the pattern-printed layer in the first substrate sheet and/or the third substrate sheet.

3. A process for the preparation of a decorative sheet, which comprises the following steps:
   1C) performing buildup printing on one surface of a second substrate sheet or third substrate sheet with an ink comprising a curable resin as the vehicle to form a pattern-printed layer;
   2C) curing the pattern-printed layer and heat-compressing the substrate sheet by using an embossing plate to embed the pattern-printed layer in the second or third substrate sheet and form an embossed pattern on the printed surface; and

3C) piling a first substrate sheet on the printed surface of the second or third substrate sheet and compressing or heat-compressing the assembly to effect the lamination.

4. A preparation process according to any of claims 1 through 3 , wherein the step 3A), 3B) or 3C) of laminating the substrate sheets includes an operation of embossing the sheet surface by using an embossing plate at the heat compression of the piled substrate sheets.

5. A process for the preparation of a decorative sheet, which comprises the following steps:
1D) performing buildup printing of one or both of surfaces of a first substrate sheet with an ink comprising an ionizing radiation-curable resin or its mixture with an ionizing radiation-uncurable resin as the vehicle to form a pattern-printed layer;
2-1) semi-curing the pattern-printed layer by irradiation with an ionizing radiation;
2-2) coating an ionizing radiation-uncurable resin or its mixture with an ionizing radiation-curable resin on the semi-cured pattern-printed layer to form a primer layer;
2-3) irradiating the assembly with an ionizing radiation again to completely cure the pattern-printed layer; and
3D) piling a second substrate sheet and/or a third substrate sheet on the first substrate sheet and compressing or heat-compressing the assembly to embed the pattern-printed layer in one or two or more of the substrate sheets.

6. A process for the preparation of a decorative sheet, which comprises the following steps:
1E) performing buildup printing of one surface of a third substrate sheet with an ink comprising an ionizing radiation-curable resin or its mixture with an ionizing radiation-uncurable resin as the vehicle to form a pattern-printed layer 2;
2-1) semi-curing the pattern-printed layer by irradiation with an ionizing radiation;
2-2) coating an ionizing radiation-uncurable resin or its mixture with an ionizing radiation-curable resin on the semi-cured pattern-printed layer to form a primer layer;
2-3) irradiating the assembly with an ionizing radiation again to completely cure the pattern-printed layer; and
3E) piling a first substrate sheet on the printed surface of the third substrate sheet and heat-compressing the assembly to effect lamination so that the pattern-printed layer is embedded.

7. A process for the preparation of a decorative sheet according to any of claims 1 , 5 and 6, wherein a sheet of a heat-curable resin or ionizing radiation-curable resin which is a non-sticky solid even in the uncured state has a higher hardness and a lower compressibility than those of the pattern-printed layer is used as the first, second or third substrate sheet in which the pattern-printed layer is to be embedded, the step 3), 3A), 3B), 3D) or 3E) is carried out by performing compression or heat compression in the state where said substrate sheet is uncured and performing lamination to embed the pattern-printed layer, and then, said substrate sheet is cured by application of heat or irradiation with an ionizing radiation.

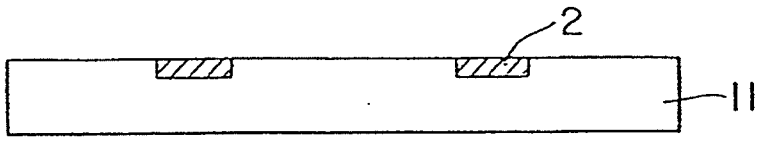


FIG. 1

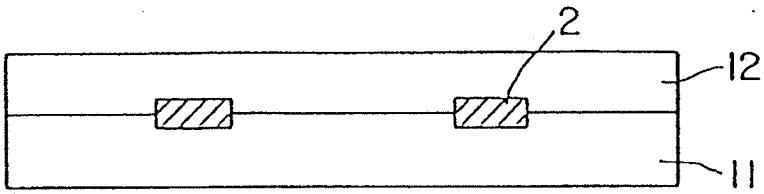


FIG. 2

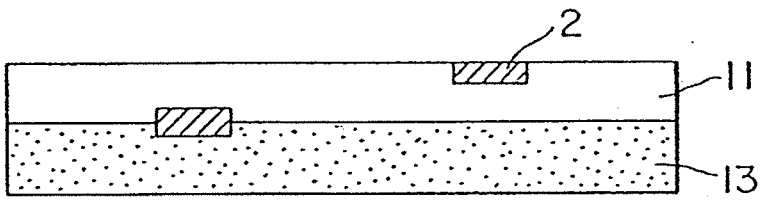


FIG. 3

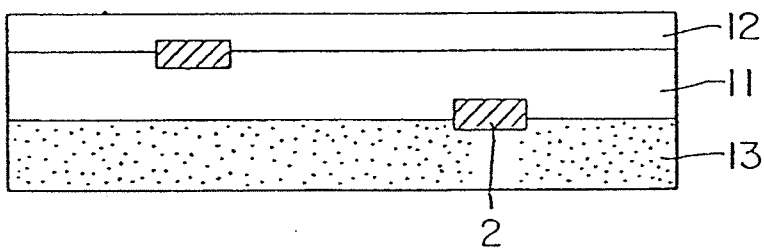


FIG. 4

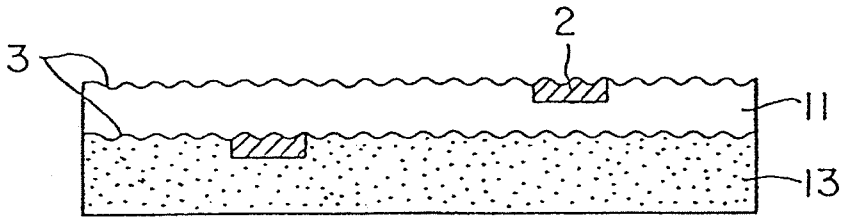


FIG. 5

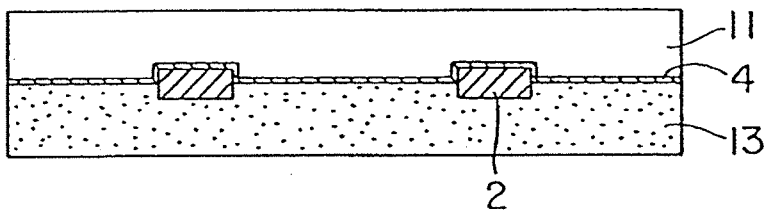


FIG. 6

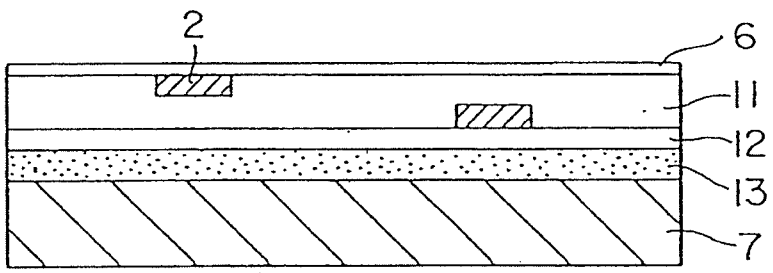


FIG. 7

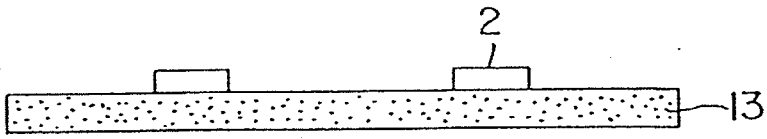


FIG. 8

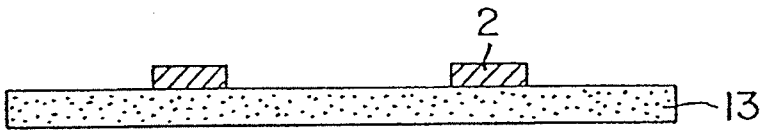


FIG. 9

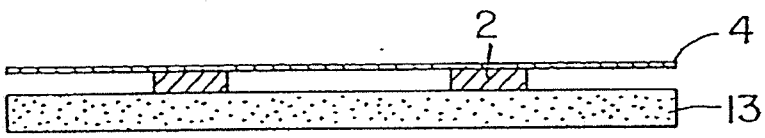


FIG. 10

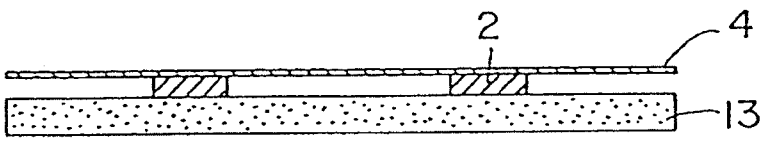


FIG. 11

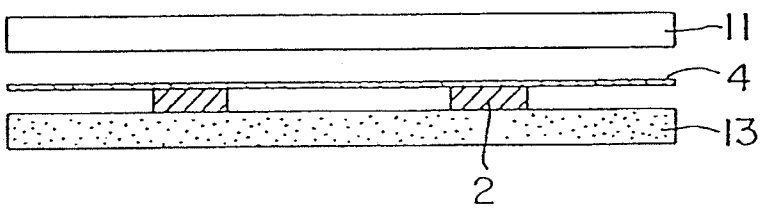


FIG. 12

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## (54) Process for the preparation of decorative sheet.

(57) A process is provided for the preparation of a decorative sheet which comprises a first substrate sheet (11) formed of a transparent plastic material, in one or both of the surfaces of which all or a part of a pattern-printed layer (2) is embedded, a laminated sheet formed by laminating a second substrate sheet (12) formed of a transparent plastic material on one surface of the above-mentioned sheet, or a laminated sheet formed by laminating a third substrate sheet (13) formed of a plastic material having a hiding power on the above-mentioned sheet or laminated sheet. This decorative sheet has an excellent three-dimensional effect.

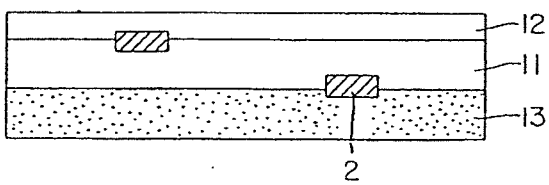


FIG. 4

EP 0 616 906 A3

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 94 10 9108

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.5) |
|---|---|---|---|
| E | GB-A-2 229 965 (DAI NIPPON INSATSU KABUSHIKI KAISHA)<br>* page 1, line 1 - page 13, line 7 * | 1-4 | B44C5/04<br>B41M1/30<br>B41M1/24 |
| Y | US-A-4 499 126 (N. SUZUKI ET. AL.)<br>* column 1, line 40 - column 4, line 17 * | 1-4 | |
| Y | PATENT ABSTRACTS OF JAPAN<br>vol. 9, no. 238 (M-416)25 September 1985<br>& JP-A-60 092 833 (TOPPAN INSATSU KK) 24 May 1985<br>* abstract * | 1-4 | |
| A | US-A-4 117 181 (K. MINAMI ET. AL.)<br>* column 2, line 22 - column 4, line 54 *<br>* examples 1,2 * | 7 | |

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

B44C
B41M

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 21 September 1994 | Doolan, G |

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